PB83-163949

Development Document for Effluent Limitations Guidelines, New Source Performance Standards, and Pretreatment Standards for the Pulp, Paper, and Paperboard and the Builders' Paper and Board Mills Point Source Categories

(U.S.) Environmental Protection Agency
Washington, DC

Oct 82

U.S. Department of Commerce
National Technical Information Service
NTIS

United States
Environmental Protection
Agency

Effluent Guidelines Division
WH-552
Washington DC 20460

EPA 440/1-82/025
October 1982

PB83-163949

Water and Waste Management

EPA

Development Document for Effluent Limitations Guidelines and Standards for the Pulp, Paper and Paperboard

Final

Point Source Category

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

TECHNICAL REPORT DATA

(Please read Instructions on the reverse before completing)

1. REPORT NO.
440/1-82/025

2.

3. RECIPIENT'S ACCESSION NO.
PB83 163949

4. TITLE AND SUBTITLE
Development Document for Effluent Limitations Guidelines and Standards for the Pulp, Paper and Paperboard Point Source Category

5. REPORT DATE

6. PERFORMING ORGANIZATION CODE

7. AUTHOR(S)

8. PERFORMING ORGANIZATION REPORT NO.

9. PERFORMING ORGANIZATION NAME AND ADDRESS
U.S. Environmental Protection Agency
Office of Water
401 M St. S.W.
Washington, DC 20460

10. PROGRAM ELEMENT NO.

11. CONTRACT/GRANT NO.

12. SPONSORING AGENCY NAME AND ADDRESS
U.S. Environmental Protection Agency
Office of Water
401 M Street S.W.
Washington, DC 20460

13. TYPE OF REPORT AND PERIOD COVERED

14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

16. ABSTRACT

This document presents the findings of a study of the pulp, paper, and paperboard and the builders' paper and board mills point source categories. The purpose of this study was to develop effluent limitations guidelines for existing and new point sources and to establish pretreatment standards for existing and new dischargers to publicly owned treatment works. These regulations were promulgated in October of 1982 under the authority of Sections 301, 304, 306, 307, 308, and 501 of the Clean Water Act (the Federal Water Pollution Control Act Amendments of 1972, 33 USC 1251 et seq., as amended by the Clean Water Act of 1977, P.L. 95-217 (the "Act") and in response to the Settlement Agreement in Natural Resources Defense Council, Inc. v. Train 8 ERC 2120 (D.D.C. 1976), modified, 12 ERC 1833 (D.D.C. 1979).

The information presented in this document supports the following promulgated regulations: best practivable control technology currently available (BPT), best available technology economically achievable (BAT), new source performance standards (NSPS), and pretreatment standards for new and existing sources (PSNS and PSES) for the pulp, paper, and paperboard and the builders' paper and board mills point source categories. In this report, information is presented on data gathering efforts, subcategorization, water use, pollutant parameters, control and treatment technologies, development of regulatory options, cost and non-water quality considerations, and the methodology for development of effluent limitations.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group

18. DISTRIBUTION STATEMENT
Release Unlimited

19. SECURITY CLASS *(This Report)*
Unclassified

20. SECURITY CLASS *(This page)*
Unclassified

21. NO. OF PAGES

22. PRICE

EPA Form 2220-1 (9-73)

INSTRUCTIONS

1. **REPORT NUMBER**
Insert the EPA report number as it appears on the cover of the publication.

2. **LEAVE BLANK**

3. **RECIPIENTS ACCESSION NUMBER**
Reserved for use by each report recipient.

4. **TITLE AND SUBTITLE**
Title should indicate clearly and briefly the subject coverage of the report, and be displayed prominently. Set subtitle, if used, in smaller type or otherwise subordinate it to main title. When a report is prepared in more than one volume, repeat the primary title, add volume number and include subtitle for the specific title.

5. **REPORT DATE**
Each report shall carry a date indicating at least month and year. Indicate the basis on which it was selected *(e.g., date of issue, date of approval, date of preparation, etc.)*.

6. **PERFORMING ORGANIZATION CODE**
Leave blank.

7. **AUTHOR(S)**
Give name(s) in conventional order *(John R. Doe, J. Robert Doe, etc.)*. List author's affiliation if it differs from the performing organization.

8. **PERFORMING ORGANIZATION REPORT NUMBER**
Insert if performing organization wishes to assign this number.

9. **PERFORMING ORGANIZATION NAME AND ADDRESS**
Give name, street, city, state, and ZIP code. List no more than two levels of an organizational hirearchy.

10. **PROGRAM ELEMENT NUMBER**
Use the program element number under which the report was prepared. Subordinate numbers may be included in parentheses.

11. **CONTRACT/GRANT NUMBER**
Insert contract or grant number under which report was prepared.

12. **SPONSORING AGENCY NAME AND ADDRESS**
Include ZIP code.

13. **TYPE OF REPORT AND PERIOD COVERED**
Indicate interim final, etc., and if applicable, dates covered.

14. **SPONSORING AGENCY CODE**
Leave blank.

15. **SUPPLEMENTARY NOTES**
Enter information not included elsewhere but useful, such as: Prepared in cooperation with, Translation of, Presented at conference of, To be published in, Supersedes, Supplements, etc.

16. **ABSTRACT**
Include a brief *(200 words or less)* factual summary of the most significant information contained in the report. If the report contains a significant bibliography or literature survey, mention it here.

17. **KEY WORDS AND DOCUMENT ANALYSIS**
(a) DESCRIPTORS - Select from the Thesaurus of Engineering and Scientific Terms the proper authorized terms that identify the major concept of the research and are sufficiently specific and precise to be used as index entries for cataloging.

(b) IDENTIFIERS AND OPEN-ENDED TERMS - Use identifiers for project names, code names, equipment designators, etc. Use open-ended terms written in descriptor form for those subjects for which no descriptor exists.

(c) COSATI FIELD GROUP - Field and group assignments are to be taken from the 1965 COSATI Subject Category List. Since the majority of documents are multidisciplinary in nature, the Primary Field/Group assignment(s) will be specific discipline, area of human endeavor, or type of physical object. The application(s) will be cross-referenced with secondary Field/Group assignments that will follow the primary posting(s).

18. **DISTRIBUTION STATEMENT**
Denote releasability to the public or limitation for reasons other than security for example "Release Unlimited." Cite any availability to the public, with address and price.

19. & 20. **SECURITY CLASSIFICATION**
DO NOT submit classified reports to the National Technical Information service.

21. **NUMBER OF PAGES**
Insert the total number of pages, including this one and unnumbered pages, but exclude distribution list, if any.

22. **PRICE**
Insert the price set by the National Technical Information Service or the Government Printing Office, if known.

DEVELOPMENT DOCUMENT
for
EFFLUENT LIMITATIONS GUIDELINES NEW SOURCE PERFORMANCE STANDARDS
and
PRETREATMENT STANDARDS
for the
PULP, PAPER, AND PAPERBOARD
and the
BUILDERS' PAPER AND BOARD MILLS POINT SOURCE CATEGORIES

Anne M. Gorsuch
Administrator

Jeffery D. Denit
Director, Effluent Guidelines Division

Robert W. Dellinger
Senior Project Officer
and
Acting Chief, Wood Products and Fibers Branch

Wendy D. Smith
Project Officer

October 1982

Effluent Guidelines Division
Office of Water
U.S. Environmental Protection Agency
Washington, D.C. 20460

ABSTRACT

This document presents the findings of a study of the pulp, paper, and paperboard and the builders' paper and board mills point source categories. The purpose of this study was to develop effluent limitations guidelines for existing and new point sources and to establish pretreatment standards for existing and new dischargers to publicly owned treatment works. These regulations were promulgated in October of 1982 under the authority of Sections 301, 304, 306, 307, 308, and 501 of the Clean Water Act (the Federal Water Pollution Control Act Amendments of 1972, 33 USC 1251 et seq., as amended by the Clean Water Act of 1977, P.L. 95-217 (the "Act")) and in response to the Settlement Agreement in Natural Resources Defense Council, Inc. v. Train, 8 ERC 2120 (D.D.C. 1976), modified, 12 ERC 1833 (D.D.C. 1979).

The information presented in this document supports the following promulgated regulations: best practicable control technology currently available (BPT), best available technology economically achievable (BAT), new source performance standards (NSPS), and pretreatment standards for new and existing sources (PSNS and PSES) for the pulp, paper, and paperboard and the builders' paper and board mills point source categories. In this report, information is presented on data gathering efforts, subcategorization, water use, pollutant parameters, control and treatment technologies, development of regulatory options, cost and non-water quality considerations, and the methodology for development of effluent limitations.

TABLE OF CONTENTS

SECTION PAGE

I CONCLUSIONS 1

SUBCATEGORIZATION 1
BPT 3
BAT 5
NSPS 5
PSES and PSNS 12
IMPACT OF THE REGULATIONS 12
  Existing Sources 12
  New Sources 17

II INTRODUCTION 19

PURPOSE AND AUTHORITY 19
STATUS OF THE EFFLUENT LIMITATIONS GUIDELINES 21
SCOPE OF THIS RULEMAKING 23
SUMMARY OF METHODOLOGY 24
  Introduction 24
  Existing Data Evaluation 26
  Data Request Program 29
  Screening Program 31
  Industry Profile and Review of Subcategorization 42
  Verification Program 44
  Long-Term Sampling Program 56
  Discharge Monitoring Data Acquisition Program 60
  Supplemental Data Acquisition Program 61
  PCB Data Acquisition Program 63
  Data Obtained from Industry on Proposed Regulations 63
  Analysis of Treatment Alternatives 63
  Analysis of Cost and Energy Data 66

III DESCRIPTION OF THE INDUSTRY 67

INTRODUCTION 67
RAW MATERIALS 67
STANDARD MANUFACTURING PROCESSES 67
  Raw Material Preparation 68
  Pulping 68
  Use of Secondary Fibers 71
  Bleaching of Wood Pulps 72
  Papermaking 75
INDUSTRY PROFILE 77
  Geographical Distribution 77
  Method of Wastewater Discharge 77
  Production Profile 83

SECTION		PAGE
IV	SUBCATEGORIZATION	89
	INTRODUCTION	89
	INTEGRATED SEGMENT	90
	SECONDARY FIBERS SEGMENT	93
	NONINTEGRATED SEGMENT	95
	MISCELLANEOUS MILLS	97
	IMPACT OF TOXIC POLLUTANT DATA	97
	SUMMARY	97
	Dissolving Kraft	98
	Market Bleached Kraft	98
	BCT (Board, Coarse, and Tissue) Bleached Kraft	99
	Fine Bleached Kraft	99
	Soda	99
	Unbleached Kraft	99
	Semi-Chemical	99
	Unbleached Kraft and Semi-Chemical	99
	Dissolving Sulfite Pulp	100
	Papergrade Sulfite (Blow Pit Wash)	100
	Papergrade Sulfite (Drum Wash)	100
	Groundwood - Thermo-Mechanical	100
	Groundwood-CMN (Coarse, Molded, News) Papers	100
	Groundwood-Fine Papers	101
	Groundwood-Chemi-Mechanical	101
	Deink	101
	Tissue From Wastepaper	101
	Paperboard from Wastepaper	101
	Wastepaper-Molded Products	102
	Builders' Paper and Roofing Felt	102
	Nonintegrated-Fine Papers	102
	Nonintegrated-Tissue Papers	102
	Nonintegrated-Lightweight Papers	102
	Nonintegrated-Filter and Nonwoven Papers	102
	Nonintegrated-Paperboard	102
V	WATER USE AND WASTE CHARACTERIZATION	103
	WATER USE AND SOURCES OF WASTEWATER	103
	Wood Preparation	103
	Pulping and Recovery	105
	Bleaching	109
	Papermaking	111
	WASTE CHARACTERIZATION STRATEGY	112
	Conventional Pollutants	112
	TOXIC AND NONCONVENTIONAL POLLUTANTS	183
	Screening Program	183
	Verification Program	193
	Long-Term Sampling Program	193
	Summary	235
	Supplemental Data on Nonconventional Pollutants	235

SECTION PAGE

VI SELECTION OF POLLUTANT PARAMETERS 241

WASTEWATER PARAMETERS OF SIGNIFICANCE 241
SELECTION OF WASTEWATER PARAMETERS OF SIGNIFICANCE 241
  Conventional Pollutants 241
  Toxic Pollutants 241
  Nonconventional Pollutants 243
  Review of Previous Regulations 244
  Identification of Other Compounds of Concern 246

VII CONTROL AND TREATMENT TECHNOLOGY 275

INTRODUCTION 275
PRODUCTION PROCESS CONTROLS COMMONLY EMPLOYED BY THE PULP, PAPER, AND PAPERBOARD INDUSTRY 275
  Woodyard/Woodroom 277
  Pulp Mill 281
  Brown Stock Washers and Screen Room 287
  Bleaching Systems 290
  Evaporation and Recovery 293
  Liquor Preparation Area 303
  Papermill 303
  Steam Plant and Utility Areas 319
  Recycle of Effluent 319
  Chemical Substitution 321
OTHER PRODUCTION PROCESS CONTROLS 323
  Bleach Systems and Recovery 323
END-OF-PIPE TREATMENT TECHNOLOGIES COMMONLY EMPLOYED BY THE PULP, PAPER, AND PAPERBOARD INDUSTRY 330
  Preliminary/Primary Treatment 330
  Biological Treatment 331
  Chemically Assisted Clarification 347
  Filtration 361
  Activated Carbon Adsorption 363
  Foam Separation 377
  Microstraining 379
  Electrochemical Treatment 379
  Ion Flotation 380
  Air/Catalytic/Chemical Oxidation 381
  Steam Stripping 381
  Ultrafiltration 382
  Reverse Osmosis/Freeze Concentration 383
  Amine Treatment 383
  Polymeric Resin Treatment 384

SECTION PAGE

- VIII DEVELOPMENT OF CONTROL AND TREATMENT OPTIONS 387
  - INTRODUCTION 387
  - BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE (BPT) 387
    - General 387
    - Development of Raw Waste Loads 388
    - Development of Final Effluent Characteristics 391
  - BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY (BCT) 395
    - General 395
  - NEW SOURCE PERFORMANCE STANDARDS-CONVENTIONAL POLLUTANTS 396
    - General 396
    - Option 1 397
    - Attainment of NSPS Option 1 432
    - Option 2 442
    - Attainment of NSPS Option 2 470
    - Conventional Pollutant Variability Analysis 470
  - TOXIC AND NONCONVENTIONAL POLLUTANT REMOVAL TECHNOLOGY ASSESSMENT 489
    - Chlorophenolics 492
    - Zinc 504
    - Chloroform 504
    - Ammonia 509
    - Color 512
- IX EFFLUENT REDUCTION ATTAINABLE THROUGH THE APPLICATION OF THE BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE EFFLUENT LIMITATIONS GUIDELINES 517
  - GENERAL 517
  - REGULATED POLLUTANTS 517
  - IDENTIFICATION OF THE BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE 517
  - BPT EFFLUENT LIMITATIONS 518
  - RATIONALE FOR THE SELECTION OF THE TECHNOLOGY BASIS OF BPT 518
  - METHODOLOGY USED FOR DEVELOPMENT OF BPT EFFLUENT LIMITATIONS 520
  - COST OF APPLICATION AND EFFLUENT REDUCTION BENEFITS 522
  - NON-WATER QUALITY ENVIRONMENTAL IMPACTS 522
    - Energy 524
    - Solid Waste 524
    - Air and Noise 524

SECTION PAGE

X EFFLUENT REDUCTION ATTAINABLE THROUGH THE APPLICATION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE EFFLUENT LIMITATIONS GUIDELINES 525

GENERAL 525
REGULATED POLLUTANTS 525
Toxic Pollutants 525
IDENTIFICATION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE 526
BAT EFFLUENT LIMITATIONS 526
RATIONALE FOR THE SELECTION OF THE TECHNOLOGY BASIS OF BAT 526
METHODOLOGY USED FOR DEVELOPMENT OF BAT EFFLUENT LIMITATIONS 529
Zinc 529
Trichlorophenol 529
Pentachlorophenol 530
COST OF APPLICATION AND EFFLUENT REDUCTION BENEFITS 530
Fungicide and Slimicide Substitution 530
Zinc Removal 530
NON-WATER QUALITY ENVIRONMENTAL IMPACTS 530

XI EFFLUENT REDUCTION ATTAINABLE THROUGH THE APPLICATION OF BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY EFFLUENT LIMITATIONS GUIDELINES 533

GENERAL 533

XII NEW SOURCE PERFORMANCE STANDARDS 535

GENERAL 535
REGULATED POLLUTANTS 535
Conventional Pollutants 535
Toxic Pollutants 535
Nonconventional Pollutants 535
IDENTIFICATION OF THE TECHNOLOGY BASIS OF NSPS 535
Conventional Pollutant Control 535
Toxic Pollutant Control 535
NEW SOURCE PERFORMANCE STANDARDS 536
RATIONALE FOR THE SELECTION OF THE TECHNOLOGY BASIS FOR NSPS 536
Conventional Pollutant Control Technology 536
Toxic Pollutant Control Technology 541
METHODOLOGY USED FOR DEVELOPMENT OF NSPS 542
Conventional Pollutants 542
Toxic Pollutants 542
COST OF APPLICATION AND EFFLUENT REDUCTION BENEFITS 544
NON-WATER QUALITY ENVIRONMENTAL IMPACTS 544

SECTION PAGE

XIII PRETREATMENT STANDARDS FOR EXISTING SOURCES 545

GENERAL 545
REGULATED POLLUTANTS 545
IDENTIFICATION OF THE TECHNOLOGY BASIS OF PRETREATMENT STANDARDS FOR EXISTING SOURCES 545
PSES 545
RATIONALE FOR THE SELECTION OF THE TECHNOLOGY BASIS OF PSES 548
METHODOLOGY USED FOR DEVELOPMENT OF PSES 548
Zinc 549
Trichlorophenol 549
Pentachlorophenol 549
COST OF APPLICATION AND EFFLUENT REDUCTION BENEFITS 550
Fungicide and Slimicide Substitution 550
Zinc Hydrosulfite Substitution 550
NON-WATER QUALITY ENVIRONMENTAL IMPACTS 550

XIV PRETREATMENT STANDARDS FOR NEW SOURCES 553

GENERAL 553
REGULATED POLLUTANTS 553
IDENTIFICATION OF THE TECHNOLOGY BASIS OF PRETREATMENT STANDARDS FOR NEW SOURCES 553
PSNS 553
RATIONALE FOR THE SELECTION OF THE TECHNOLOGY BASIS OF PSNS 553
METHODOLOGY USED FOR DEVELOPMENT OF PSNS 556
COST OF APPLICATION 557
NON-WATER QUALITY ENVIRONMENTAL IMPACTS 557

XV ACKNOWLEDGEMENTS 559

SECTION PAGE

APPENDICES

APPENDIX A - COST, ENERGY, AND NON-WATER QUALITY ASPECTS 561

METHODOLOGY FOR DEVELOPMENT OF COSTS 561
Introduction 561
Model Mill Approach 561
Mill and Site Specific Cost Factors 564
Cost Estimating Criteria for Control and Treatment Technologies 567
COSTS FOR IMPLEMENTATION OF BPT 570
COSTS FOR IMPLEMENTATION OF BAT OPTIONS 573
Toxic Pollutant Control Options 573
Nonconventional Pollutant Control Options 576
COSTS FOR IMPLEMENTATION OF PSES AND PSNS 582
COSTS FOR IMPLEMENTATION OF NSPS CONTROL AND TREATMENT OPTIONS 583
Conventional Pollutant Removal 583
Toxic Pollutant Removal 583
ENERGY AND NON-WATER QUALITY IMPACTS 594
Energy Requirements 594
Air Pollution 596
Noise Potential 599
Solid Waste Generation 599
Implementation Requirements 605

APPENDIX B - GLOSSARY 607

APPENDIX C - LEGEND OF ABBREVIATIONS 625

APPENDIX D - REFERENCES 635

LIST OF TABLES

TITLE PAGE

SECTION I

I-1 BPT Effluent Limitations 4

I-2 BAT Effluent Limitations 6

I-3 BAT Effluent Limitations--Noncontinuous Dischargers 7

I-4 New Source Performance Standards--Conventional Pollutants 8

I-5 New Source Performance Standards--Conventional Pollutants--Noncontinuous Dischargers 9

I-6 New Source Performance Standards--Toxic Pollutants 10

I-7 New Source Performance Standards--Toxic Pollutants--Noncontinuous Dischargers 11

I-8 Pretreatment Standards for Existing Sources 13

I-9 Pretreatment Standards for New Sources 15

SECTION II

II-1 Status of Effluent Limitations Guidelines 22

II-2 Response to Data Request 32

II-3 Toxic and Additional Nonconventional Pollutants Under Investigation in the Screening Program 33

II-4 Subcategory Groups Selected for Screening Program 37

II-5 Summary of Treatment Type and Percent Differences--Contractor Screening for Mills Versus Raw Waste Load Basis of BPT 38

II-6 Typical Screening Program Survey 41

II-7 Subcategorization Scheme on Which BPT Was Based and the Revised Subcategorization Scheme 43

II-8 Verification Compounds--Pulp, Paper, and Paperboard Industry 46

II-9 Verification Program Sampling Points 51

II-10 Typical Verification Sampling Program Survey 52

	TITLE	PAGE
II-11	Summary of Internal Standards	55
II-12	Toxic and Nonconventional Pollutants Selected for Analysis During the Long-Term Sampling Program	57
II-13	Summary of Direct Discharging Mills Versus DMR Data Collected	62
II-14	Production Process Controls and Effluent Treatment Technologies	64
SECTION III		
III-1	Bleaching Symbols	74
III-2	Summary of All Known Operating Pulp, Paper, and Paperboard Mills by EPA Region	78
III-3	Summary of Method of Discharge and In-Place Technology--All Known Operating Mills	81
III-4	Estimated Pulp Production - 1977	84
III-5	Paper and Paperboard Products of Industry	85
III-6	Production Statistics--Paper and Paperboard Products Industry	86
SECTION V		
V-1	Summary Raw Waste Load Data--Dissolving Kraft Subcategory	113
V-2	Summary Raw Waste Load Data--Market Bleached Kraft Subcategory	118
V-3	Summary Raw Waste Load Data--BCT Bleached Kraft Subcategory	121
V-4	Summary Raw Waste Load Data--Alkaline-Fine	125
V-5	Summary Raw Waste Load Data--Unbleached Kraft Subcategory	130
V-6	Summary Raw Waste Load Data--Semi-Chemical Subcategory	133
V-7	Summary Raw Waste Load Data--Unbleached Kraft and Semi-Chemical Subcategory	137

	TITLE	PAGE
V-8	Summary Raw Waste Load Data--Dissolving Sulfite Pulp Subcategory	139
V-9	Summary Raw Waste Load Data--Papergrade Sulfite Subcategory	140
V-10	Summary Raw Waste Load Data--Groundwood-Thermo-Mechanical Subcategory	149
V-11	Summary Raw Waste Load Data--Groundwood-CMN Papers Subcategory	150
V-12	Summary Raw Waste Load Data--Groundwood-Fine Papers Subcategory	153
V-13	Summary Raw Waste Load Data-Integrated Miscellaneous Mills	157
V-14	Summary Raw Waste Load Data--Deink Subcategory	160
V-15	Summary Raw Waste Load Data--Tissue from Wastepaper Subcategory	163
V-16	Summary Raw Waste Load Data--Paperboard from Wastepaper Subcategory	164
V-17	Methods of Wastewater Disposal at Self-Contained Paperboard from Wastepaper Mills	169
V-18	Summary Raw Waste Load Data--Wastepaper-Molded Products Subcategory	170
V-19	Summary Raw Waste Load Data--Builders' Paper and Roofing Felt Subcategory	171
V-20	Methods of Wastewater Disposal at Self-Contained Builders' Paper and Roofing Felt Mills	174
V-21	Summary Raw Waste Load Data--Secondary Fibers Miscellaneous Mills	175
V-22	Summary Raw Waste Load Data--Nonintegrated-Fine Papers Subcategory	176
V-23	Summary Raw Waste Load Data--Nonintegrated-Tissue Papers Subcategory	178
V-24	Summary Raw Waste Load Data--Nonintegrated-Lightweight Papers Subcategory	180

TITLE PAGE

V-25 Summary Raw Waste Load Data--Nonintegrated-Filter and Nonwoven Papers Subcategory 181
V-26 Summary Raw Waste Load Data--Nonintegrated-Paperboard Subcategory 182
V-27 Summary Raw Waste Load Data--Nonintegrated Miscellaneous Mills 184
V-28 Summary of Initial Screening Program Analysis Results 185
V-29 Summary of Screening Analysis Results at 17 Verification Mills 190
V-30 Summary of EPA Regional S&A Screening Program Results at 42 Mills 191
V-31 Summary of Verification Program Analysis Results for Toxic Pollutants 194
V-32 Summary of Verification Program Analysis Results for Nonconventional Pollutants 218
V-33 Summary of Long-Term Sampling Program Analysis Results for Toxic Pollutants 231
V-34 Summary of Long-Term Sampling Program Analysis Results for Nonconventional Pollutants 232
V-35 Toxic Pollutant Sampling Data Base 236
V-36 Supplemental Color Data 237
V-37 Theoretical Raw Waste Ammonia Load 238
V-38 Summary of Available Ammonia Data for All Mills Using Ammonia as the Chemical Pulping Base 239

SECTION VI

VI-1 Summary of Parameters Proposed or Promulgated for Effluent Limitations Guidelines by Subcategory 245
VI-2 Criteria For Elimination of Toxic Pollutants Based on Screening Program Results and Toxic Pollutants Eliminated 248
VI-3 Projected Treatability for Verification Program Toxic Pollutants 250

	TITLE	PAGE
VI-4	Toxic Pollutants Eliminated from Assessment Based on Verification Program Results--Detected Below Treatability Level	253
VI-5	Summary of Toxic Pollutants of Concern By Subcategory	255
VI-6	Summary of Data Assessment-Toxic Pollutants of Concern	256
VI-7	Criteria for Elimination of Toxic Pollutants Based on Verification Program Results and Toxic Pollutants Eliminated	260
VI-8	Exclusion of Toxic Pollutants of Potential Concern from Pretreatment Standards	263
VI-9	Summary of Influent Concentrations for Resin and Fatty Acids and Chlorinated Derivatives for All Verification Facilities	265
VI-10	Summary of Effluent Concentrations for Resin and Fatty Acids and Chlorinated Derivatives for All Verification Facilities	267
VI-11	Summary of Influent Concentrations for Resin and Fatty Acids and Chlorinated Derivatives for Verification Mills Meeting BPT Effluent Limitations	269
VI-12	Summary of Effluent Concentrations for Resin and Fatty Acids and Chlorinated Derivatives for Verification Mills Meeting BPT Effluent Limitations	270
VI-13	Removals of Resin and Fatty Acids and Chlorinated Derivatives	272

SECTION VII

VII-1	Production Process Control Technologies Identified as the Best Practicable Control Technology Currently Available	276
VII-2	Production Process Control Technologies Identified as the Best Available Technology Economically Achievable	276
VII-3	Production Process Control Technologies Available for Reduction of Effluent Volume and Pollutant Loadings	278
VII-4	Waste Load Reductions From Implementation of Hooker APS II and APS III Systems	329

TITLE PAGE

VII-5 Calculated Toxic and Nonconventional Pollutant Removal Rates 333

VII-6 Typical Design Parameters for Activated Sludge Processes 337

VII-7 Oxygen Activated Sludge Treatability -- Pilot Scale 341

VII-8 Pilot RBC Final Effluent Quality for Bleached Kraft Wastewater 343

VII-9 Summary of Chemically Assisted Clarification Technology Performance Data 349

VII-10 Final Effluent Quality of a Chemically Assisted Clarification System Treating Bleached Kraft Wastewater 351

VII-11 Final Effluent Quality of a Chemically Assisted Clarification System Treating Wastewater from a Deink-Newsprint Mill 352

VII-12 Color and Organic Carbon Removal After Application of Massive Lime Treatment 355

VII-13 Color Reductions Achieved After Application of Chemically Assisted Clarification With Ferric Sulfate, Alum, and Lime 358

VII-14 Comparison of Treatment Efficiencies On Kraft Effluents by the Application of Chemically Assisted Clarification Using Divalent Ions or Trivalent Ions 359

VII-15 Lime Treatment of Bleached Kraft Caustic Extract in the Presence of Metal Ion 360

VII-16 Removal of BOD, COD, and Phosphate from Chemical Pulping Wastewaters at Selected Lime-Magnesia Levels 362

VII-17 TSS Reduction Capabilities and Related Factors for the Filtration Technology When No Chemicals Are Used 364

VII-18 TSS Reduction Capabilities and Related Factors for the Filtration Technology When Chemicals are Used 365

VII-19 Final Effluent Quality Following Three Layer Pressure Sand Filtration of the Effluent From an Aerated Stabilization Basin Treating Paperboard From Wastepaper Wastewater 366

	TITLE	PAGE
VII-20	Final Effluent Quality Following Deep Bed Sand Filtration of the Effluent From an Aerated Stabilization Basin and Secondary Clarifier Treating Paperboard From Wastepaper Wastewater	367
VII-21	Final Effluent Quality Following Rapid Gravity Sand Filtration of the Effluent From an Activated Sludge Plant Treating Paperboard from Wastepaper Wastewater	368
VII-22	Sand Filtration Results	369
VII-23	Results of Pilot-Scale Granular Activated Carbon Treatment of Unbleached Kraft Mill Waste	373
VII-24	Powdered Activated Carbon Operating Data On a Chemical Plant Wastewater	375
VII-25	Full Scale "PACT" Process Results On Chemical Plant Wastewater	376
VII-26	Results of Pilot-Scale Activated Carbon Treatment of Unbleached Kraft Mill Effluent	378
SECTION VIII		
VIII-1	Average Raw Waste Characteristics for the Nonintegrated Segment of the Pulp, Paper, and Paperboard Industry	389
VIII-2	BPT Long-Term Average Final Effluent Characteristics	394
VIII-3	Summary of NSPS Option 1 Raw Waste Loads	398
VIII-4	Discharge Monitoring Report Data--Dissolving Kraft Subcategory	400
VIII-5	Discharge Monitoring Report Data--Market Bleached Kraft Subcategory	401
VIII-6	Discharge Monitoring Report Data--BCT Bleached Kraft Subcategory	403
VIII-7	Discharge Monitoring Report Data--Alkaline-Fine	404
VIII-8	Discharge Monitoring Report Data--Unbleached Kraft Subcategory	406
VIII-9	Discharge Monitoring Report Data--Semi-Chemical Subcategory	409

	TITLE	PAGE
VIII-10	Discharge Monitoring Report Data--Unbleached Kraft and Semi-Chemical Subcategory	410
VIII-11	Discharge Monitoring Report Data--Papergrade Sulfite Subcategory	411
VIII-12	Discharge Monitoring Report Data--Dissolving Sulfite Pulp Subcategory	413
VIII-13	Discharge Monitoring Report Data--Groundwood-Thermo-Mechanical Subcategory	415
VIII-14	Discharge Monitoring Report Data--Groundwood-Fine Papers Subcategory	416
VIII-15	Discharge Monitoring Report Data--Groundwood-CMN Papers Subcategory	417
VIII-16	Discharge Monitoring Report Data--Deink Subcategory	418
VIII-17	Discharge Monitoring Report Data--Tissue from Wastepaper Subcategory	420
VIII-18	Discharge Monitoring Report Data--Paperboard from Wastepaper Subcategory	421
VIII-19	Discharge Monitoring Report Data--Wastepaper-Molded Products Subcategory	424
VIII-20	Discharge Monitoring Report Data--Builders' Paper and Roofing Felt Subcategory	425
VIII-21	Discharge Monitoring Report Data--Nonintegrated-Fine Papers Subcategory	426
VIII-22	Discharge Monitoring Report Data--Nonintegrated-Tissue Papers Subcategory	427
VIII-23	Discharge Monitoring Report Data--Nonintegrated-Lightweight Papers Subcategory	429
VIII-24	Discharge Monitoring Report Data--Nonintegrated-Filter and Nonwoven Papers Subcategory	430
VIII-25	Discharge Monitoring Report Data--Nonintegrated-Paperboard Subcategory	431

TITLE PAGE

VIII-26 NSPS Option 1 Long-Term Average Discharge Characteristics 433

VIII-27 Number of Facilities That Attain BPT and NSPS Option 1 Final Effluent Characteristics 434

VIII-28 Percent Reductions Required to Attain NSPS Option 1 BOD_5 Final Effluent Characteristics From NSPS Option 1 BOD_5 Raw Waste Loads 435

VIII-29 Percent BOD_5 Reductions Attained at Some Mills Meeting BPT BOD_5 and TSS Final Effluent Levels 436

VIII-30 A Comparison of NSPS Design Criteria to BPT Design Criteria 440

VIII-31 A Comparison of NSPS Option 1 Design Criteria to Criteria Used at Integrated Mills Where BOD_5 Reductions Comparable to Those Required to Attain NSPS Option 1 Are Achieved 441

VIII-32 Production Process Controls Forming the Basis of Cost Estimates for NSPS Option 2--Integrated Segment 443

VIII-33 Production Process Controls Forming the Basis of Cost Estimates for NSPS Option 2 -- Secondary Fibers Segment 445

VIII-34 Production Process Controls Forming the Basis of Cost Estimates for NSPS Option 2 -- Nonintegrated Segment 447

VIII-35 Production Process Controls in Addition to Those That Form the Basis of BPT That Can Be Employed to Achieve NSPS Option 2 Raw Waste Loads--Integrated Segment 449

VIII-36 Production Process Controls in Addition to Those That Form the Basis of BPT That Can Be Employed to Achieve NSPS Option 2 Raw Waste Loads--Secondary Fibers Segment 451

VIII-37 Production Process Controls in Addition to Those That Form the Basis of BPT That Can Be Employed to Achieve NSPS Option 2 Raw Waste Loads--Nonintegrated Segment 452

VIII-38 Summary of NSPS Option 2 Raw Waste Loads 464

VIII-39 Comparison of NSPS Option 1 Raw Waste Loads and Final Effluent Levels with NSPS Option 2 Raw Waste Loads and Final Effluent Levels 466

	TITLE	PAGE
VIII-40	Calculation of Final Effluent Levels for Subcategories For Which the NSPS Option 2 Raw Waste BOD_5 Concentration is Greater Than the NSPS Option 1 Raw Waste BOD_5 Concentration	468
VIII-41	NSPS Option 2 Long-Term Average Discharge Characteristics	471
VIII-42	Number of Mills Attaining BPT and NSPS Option 2 Final Effluent Levels	472
VIII-43	Percent Reductions Required to Attain NSPS Option 2 BOD_5 Final Effluent Characteristics From NSPS Option 2 BOD_5 Raw Waste Loads	473
VIII-44	Distribution of Daily Values About the Estimate of the 99th Percentile	476
VIII-45	Variability Factors for Determining Maximum Day Limitations	477
VIII-46	Results of Goodness-of-Fit Tests for Successive 30-Day Averages	480
VIII-47	Distribution of 30-Day Averages About the Estimate of the 99th Percentile	483
VIII-48	Variability Factors for Determining Maximum 30-Day Limitations	484
VIII-49	Average Maximum 30-Day and Maximum Day Variability Factors for Subsets (1), (2), (3), (4), (5), (6), and (7)	487
VIII-50	Summary of NSPS Variability Factors	490
VIII-51	Summary of Uncorrected Trichlorophenol Results for Mills Where Verification and Long-Term Sampling Were Conducted and Where Chlorophenolic Biocides Were Not Used	494
VIII-52	Summary of Uncorrected Trichlorophenol Results for Mills Where Verification and Long-Term Sampling Were Conducted and Where Chlorophenolic Biocides Were Used	495
VIII-53	Summary of Uncorrected Pentachlorophenol Results for Mills Where Verification and Long-Term Sampling Were Conducted and Where Chlorophenolic Biocides Were Not Used	496

	TITLE	PAGE
VIII-54	Summary of Uncorrected Pentachlorophenol Results for Mills Where Verification and Long-Term Sampling Were Conducted and Where Chlorophenolic Biocides Were Used	497
VIII-55	Summary of Corrected Trichlorophenol Results for Mills Where Chlorophenolic Biocides Were Not Used--NCASI Data	499
VIII-56	Summary of Corrected Trichlorophenol Results for Mills Where Chlorophenolic Biocides Were Used--NCASI Data	500
VIII-57	Summary of Corrected Pentachlorophenol Results for Mills Where Chlorophenolic Biocides Were Not Used --NCASI Data	502
VIII-58	Summary of Corrected Pentachlorophenol Results for Mills Where Chlorophenolic Biocides Were Used--NCASI Data	503
VIII-59	Summary of Pentachlorophenol (PCP) and Trichlorophenol (TCP) Discharge Characteristics for Direct Discharging Mills	505
VIII-60	Summary of Pentachlorophenol (PCP) and Trichlorophenol (TCP) Discharge Characteristics for Indirect Discharging Mills	506
VIII-61	Summary of Uncorrected Chloroform Biological Influent and Effluent Concentrations (ug/l) from the Verification and Long-Term Sampling Programs (Chlorine Bleaching Facilities Only)	507
VIII-62	Summary of Corrected Chloroform Effluent Data Submitted by the NCASI	510
VIII-63	Maximum Day Chloroform Variability Factors Computed Using Uncorrected Data	511
VIII-64	Predicted Range of Ammonia Raw Waste Load and Final Effluent Concentrations	513
VIII-65	Summary of Anticipated Color Levels After Minimum Lime/Alum Coagulation	514

SECTION IX

IX-1	BPT Effluent Limitations	519
IX-2	Variability Factors Used in the Development of BPT Effluent Limitations	523

	TITLE	PAGE
SECTION X		
X-1	BAT Effluent Limitations	527
SECTION XII		
XII-1	New Source Performance Standards -- Conventional Pollutants	537
XII-2	New Source Performance Standards -- Conventional Pollutants -- Noncontinuous Dischargers	538
XII-3	New Source Performance Standards -- Toxic Pollutants	539
SECTION XIII		
XIII-1	Pretreatment Standards for Existing Sources	546
SECTION XIV		
XIV-1	Pretreatment Standards for New Sources	554
APPENDIX A		
A-1	Model Mill Sizes by Subcategory and Discharge Type	562
A-2	Regional Cost Adjustment Factors	565
A-3	Cost Estimating Criteria	568
A-4	Design Criteria for BPT Activated Sludge Treatment -- Wastepaper-Molded Products Subcategory	571
A-5	Cost of Implementation of BPT Activated Sludge Treatment -- Wastepaper-Molded Products Subcategory	572
A-6	Design Criteria for Chloroform Control at Nine Mills Where Chloroform Volatilization is Inhibited	574
A-7	Cost for Chloroform Control at Nine Mills Where Chloroform Volatilization is Inhibited	575
A-8	Cost for Color Reduction for Direct Dischargers	577
A-9	Costs for Ammonia Removal for Direct Dischargers	581

	TITLE	PAGE
A-10	Costs for Substituting Sodium Hydrosulfite for Zinc Hydrosulfite	584
A-11	Design Basis for Estimates of Costs of End-of-Pipe Treatment for Attainment of NSPS Options 1 and 2	585
A-12	Cost Summary for NSPS Option 1	586
A-13	Gross Operation and Maintenance and Energy Costs and Savings for NSPS Option 2 Production Process Controls	588
A-14	Cost Summary for NSPS Option 2	589
A-15	NSPS Option 2 Production Process Controls -- Sample Cost Calculation	591
A-16	Design Parameters for NSPS Option 2 -- Example Calculation	592
A-17	Cost Summary for NSPS Option 2 Unit Process End-of-Pipe Treatment -- Example Calculation	593
A-18	Total Energy Usage at Existing Direct Discharging Mills	595
A-19	Additional Energy Usage at Existing Direct Discharging Mills with the Implementation of Color Removal Technology	597
A-20	Energy Usage at New Source Direct Discharging Mills	598
A-21	Total Wastewater Solid Waste Generation at Existing Direct Discharging Mills	601
A-22	Wastewater Solid Waste Generation at New Source Direct Discharging Mills	602
A-23	Additional Wastewater Solid Waste Generation at Direct Discharging Mills with the Implementation of Color Removal Technology	604

LIST OF FIGURES

TITLE PAGE

SECTION II

II-1 Location of Screening Program Mill Surveys 40

II-2 Location of Verification Program Mill Surveys 49

SECTION III

III-1 Location of Operating Mills in the Industry 80

SECTION V

V-1 General Flow Sheet--Pulping and Papermaking Process 104

V-2 Raw Waste Flow Versus Percent Dissolving Pulp--Dissolving Kraft Subcategory 115

V-3 Raw Waste BOD_5 Versus Percent Dissolving Pulp--Dissolving Kraft Subcategory 116

V-4 Raw Waste Data (Flow and BOD_5) Versus Percent Softwood Used--Dissolving Kraft Subcategory 117

V-5 Raw Waste Flow Versus Percent Softwood Used--Market Bleached Kraft Subcategory 119

V-6 Raw Waste BOD_5 Versus Percent Softwood Used--Market Bleached Kraft Subcategory 120

V-7 Raw Waste Flow Versus Percent Softwood Used--BCT Bleached Kraft Subcategory 122

V-8 Raw Waste BOD_5 Versus Percent Softwood Used--BCT Bleached Kraft Subcategory 123

V-9 Raw Waste Flow Versus Percent Softwood Used--Alkaline-Fine 126

V-10 Raw Waste BOD_5 Versus Percent Softwood Used--Alkaline-Fine 127

V-11 Raw Waste Flow Versus Percent On Site Pulp Production--Alkaline-Fine 128

V-12 Raw Waste BOD_5 Versus Percent On Site Pulp Production--Alkaline-Fine 129

TITLE PAGE

V-13 Raw Waste Flow Versus Production--Unbleached Kraft Subcategory 131

V-14 Raw Waste BOD_5 Versus Production--Unbleached Kraft Subcategory 132

V-15 Raw Waste Flow Versus Percent Wastepaper Used--Semi-Chemical Subcategory 135

V-16 Raw Waste BOD_5 Versus Percent Wastepaper Used--Semi-Chemical Subcategory 136

V-17 Effect of Washing Process on Raw Waste BOD_5--Papergrade Sulfite Subcategory 143

V-18 Effect of Washing Process on Raw Waste Flow--Papergrade Sulfite Subcategory 144

V-19 Raw Waste Flow Versus Percent Sulfite Pulp On-Site 145

V-20 Effect of Cooking Process on Raw Waste BOD_5--Papergrade Sulfite Subcategory 146

V-21 Effect of Condenser Type on Raw Waste Flow--Papergrade Sulfite Subcategory 148

V-22 Raw Waste Flow Versus Percent Groundwood Pulp On Site--Groundwood-CMN Papers Subcategory 151

V-23 Raw Waste BOD_5 Versus Percent Groundwood Pulp On Site--Groundwood-CMN Papers Subcategory 152

V-24 Raw Waste Flow Versus Percent Groundwood Pulp On Site--Groundwood-Fine Papers Subcategory 154

V-25 Raw Waste BOD_5 Versus Percent Groundwood Pulp On Site--Groundwood-Fine Papers Subcategory 155

V-26 Raw Waste Flow Versus Percent Deink Pulp Produced--Deink Subcategory 161

V-27 Raw Waste BOD_5 Versus Deink Pulp Produced--Deink Subcategory 162

SECTION VII

VII-1 Convert Hydraulic Barking Systems to Dry System 279

VII-2 Flume Replaced by Mechanical Conveyor 280

TITLE PAGE

VII-3 Segregate Woodroom Non-Contact Cooling Water and Condensate 282

VII-4 Reuse of Digester Blow Condensate 283

VII-5 Reduce Groundwood Thickener Filtrate Overflow 285

VII-6 Pulp Mill Spill Collection--Digester Area 286

VII-7 Addition of Third or Fourth Stage Pulp Washer 288

VII-8 Recycle Decker Filtrate 289

VII-9 Cleaner Rejects to Landfill 291

VII-10 Jump Stage Washing in Bleach Plant 292

VII-11 Full Countercurrent Washing in Bleach Plant 294

VII-12 Bleachery Jump Stage Washing and Caustic Extraction Filtrate Collection--Dissolving Sulfite Pulp 295

VII-13 Complete Reuse of Evaporator Condensate--Kraft and Soda Mills 297

VII-14 Replace Barometric Condenser With Surface Condenser 298

VII-15 Addition of an Evaporator Boilout Tank 299

VII-16 Neutralization of Spent Sulfite Liquor 301

VII-17 Spill Collection - Evaporator, Recovery, Causticizing and Liquor Storage Areas 302

VII-18 Green Liquor Dregs Filter 304

VII-19 Lime Mud Storage Pond 305

VII-20 Stock Spill Collection, Pulp Bleaching, and Papermachine Areas--Papergrade Sulfite 307

VII-21 Stock Spill Collection System--Pulp Bleaching, and Dryer Areas--Bleached Kraft and Soda Mills 308

VII-22 Stock Spill Collection System--Paper Mill Area--Groundwood-CMN or Fine Papers 309

VII-23 Spill Collection System Color Plant--Alkaline-Fine 310

	TITLE	PAGE
VII-24	Papermill Improvements--Unbleached Kraft	312
VII-25	New Saveall on Pulp & Paper Mill Effluents--Builders' Paper and Roofing Felt	313
VII-26	New Saveall on Papermill Effluents--Wastepaper-Molded Products	314
VII-27	White Water to Vacuum Pumps and Collection Tank for Pump Seal Water and Press Effluent	315
VII-28	Increased White Water Storage Capacity	317
VII-29	4-Stage Centricleaner System With Elutriation	320
VII-30	Improved Reuse of Clarifier Sludge	322
VII-31	Rapson-Reeve Process--Closed Cycle Bleached Kraft Pulpmill	325
VII-32	Rapson-Reeve Closed Cycle Mill--Salt Recovery System	327
VII-33	Billerud-Uddeholm Non-Polluting Bleach Plant	386

SECTION VIII

VIII-1	Final Effluent TSS Versus Raw Wastewater BOD_5	392
VIII-2	Final Effluent TSS Versus Final Effluent BOD_5 for the Groundwood-Fine Papers Subcategory	469
VIII-3	Average Biological Effluent Chloroform Versus Average Biological Influent Chloroform	508

APPENDIX A

A-1	Time Required to Construct Solids Contact Clarifier/ Biological System	606

SECTION I

CONCLUSIONS

SUBCATEGORIZATION

For the purpose of establishing best practicable control technology currently available (BPT) effluent limitations, best available technology economically achievable (BAT) effluent limitations, new source performance standards (NSPS), pretreatment standards for existing sources (PSES), and pretreatment standards for new sources (PSNS), EPA subcategorized the pulp, paper, and paperboard and the builders' paper and board mills point source categories into three segments as follows:

Integrated Segment

- Dissolving Kraft
- Market Bleached Kraft
- BCT (Board, Coarse, and Tissue) Bleached Kraft
- Fine Bleached Kraft
- Soda
- Unbleached Kraft
    - Linerboard
    - Bag and Other Products
- Semi-Chemical
- Unbleached Kraft and Semi-Chemical
- Dissolving Sulfite Pulp
    - Nitration
    - Viscose
    - Cellophane
    - Acetate
- Papergrade Sulfite (Blow Pit Wash)
- Papergrade Sulfite (Drum Wash)
- Groundwood-Chemi-Mechanical
- Groundwood-Thermo-Mechanical
- Groundwood-CMN (Coarse, Molded, and News) Papers
- Groundwood-Fine Papers

Secondary Fibers Segment

- Deink
    - Fine Papers
    - Tissue Papers
    - Newsprint
- Paperboard from Wastepaper
    - Corrugating Medium Furnish
    - Noncorrugating Medium Furnish
- Tissue from Wastepaper
- Wastepaper-Molded Products
- Builders' Paper and Roofing Felt

Nonintegrated Segment

- Nonintegrated - Fine Papers
  - Wood Fiber Furnish
  - Cotton Fiber Furnish
- Nonintegrated - Tissue Papers
- Nonintegrated - Lightweight Papers
  - Lightweight Papers
  - Lightweight Electrical Papers
- Nonintegrated - Filter and Nonwoven Papers
- Nonintegrated - Paperboard

The subcategorization scheme from previous Agency rulemaking efforts in 1974 and 1977 was revised based on current information. EPA considered various factors including age, size of plant, raw material, process employed, products, and waste treatability in reviewing the adequacy of the original subcategorization scheme.

EPA made the following revisions to the original subcategorization scheme relating to the integrated segment of the industry: 1) A review of available data show that no significant differences in raw waste loads exist at mills in the fine bleached kraft and soda subcategories. Therefore, BAT effluent limitations, NSPS, PSES, and PSNS are identical for both subcategories. However, because of the familiarity of permitting authorities and representatives of affected mills with the original subcategorization scheme and the format of the Code of Federal Regulations, EPA decided that the fine bleached kraft subcategory and the soda subcategory should remain as separate subcategories and that the BPT effluent limitations promulgated for those subcategories in 1977 should not be revised. 2) In the unbleached kraft subcategory, EPA determined that higher raw waste loads occur at mills where bag and other products are manufactured than at mills where only linerboard is produced. Therefore, two subgroups were established, bag and linerboard, with different BAT effluent limitations, NSPS, PSES, and PSNS. 3) In the original subcategorization scheme, there were separate subcategories for mills where the sodium and ammonia-based neutral sulfite semi-chemical (NSSC) pulping processes are employed. The Agency determined that a single new subcategory, semi-chemical, best represents all variations of the semi-chemical process. 4) The Agency established a new subcategory, the unbleached kraft and semi-chemical subcategory, which includes those mills originally included in the unbleached kraft-NSSC (cross recovery) subcategory and all other mills where both the unbleached kraft and any semi-chemical pulping processes are used. 5) The Agency determined that a single factor, the percentage of sulfite pulp produced on-site, is a better indicator of differences in raw waste loadings at papergrade sulfite mills than the type of washing system or condensers employed. Therefore, BAT effluent limitations, NSPS, PSES, and PSNS were established that are identical for the papergrade sulfite (blow pit wash) and papergrade sulfite (drum wash) subcategories. However, because of the familiarity of permitting authorities and representatives of affected mills with the original subcategorization scheme and the format of the Code of Federal

Regulations, EPA decided that the papergrade sulfite (blow pit wash) and papergrade sulfite (drum wash) subcategories should remain as separate subcategories and that the BPT effluent limitations promulgated for these subcategories in 1977 should not be revised. 6) BAT, NSPS, PSES, and PSNS regulations were not established for the groundwood-chemi-mechanical subcategory, one of the original subcategories for which BPT effluent limitations were established. Insufficient data were available to determine the effect of the degree of chemical usage in the pulping process on raw waste generation. BAT permits and NSPS for mills in this subcategory will be determined on a case-by-case basis.

In the secondary fibers segment, three revisions were made: 1) in the deink subcategory, differences in raw waste loads resulting from the production of fine papers, tissue papers, and newsprint were recognized, and different BAT effluent limitations, NSPS, PSES, and PSNS were developed for application at mills where these products are manufactured; 2) a new subcategory, wastepaper-molded products, was established to reflect distinct process and wastewater differences associated with the manufacture of molded products from wastepaper; and 3) the paperboard from wastepaper subcategory was segmented and different effluent limitations and standards were developed to account for higher raw waste loads resulting from the processing of recycled corrugating medium. (EPA made this revision after proposal in response to public comments.)

In the nonintegrated segment of the industry, three new subcategories were established to represent the differences in the manufacture of specific products. The new subcategories are nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard. Within the nonintegrated-lightweight papers subcategory, a further allowance is made to account for the production of electrical grades of paper. Additionally, the nonintegrated-fine papers subcategory was subdivided to account for higher raw waste loads resulting from the use of cotton fibers in the production of fine papers. (EPA made this revision after proposal in response to public comments.)

BPT

BPT effluent limitations were established for the four new subcategories (wastepaper-molded products, nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard) and for the two new subcategory subdivisions (the cotton fiber subdivision of the nonintegrated-fine papers subcategory and the corrugated medium furnish subdivision of the paperboard from wastepaper subcategory). These limitations control three conventional pollutants: biochemical oxygen demand (BOD_5), total suspended solids (TSS), and pH. BPT effluent limitations are shown in Table I-1.

Limitations for BOD_5 and TSS are presented in kilograms of pollutant per 1,000 kilograms of production (lb/1,000 lbs). Production shall be defined as the annual off-the-machine production (including

TABLE I-1

BPT EFFLUENT LIMITATIONS
CONTINUOUS DISCHARGERS
(kg/kkg or lbs/1000 lbs)

Subcategory	Maximum 30-Day Average		Maximum Day	
	BOD5	TSS	BOD5	TSS
Secondary Fibers Segment				
Paperboard From Wastepaper				
o Corrugating Medium Furnish	2.8	4.6	5.7	9.2
Wastepaper-Molded Products	2.3	5.8	4.4	10.8
Nonintegrated Segment				
Nonintegrated Fine Papers				
o Cotton Fiber Furnish	9.1	13.1	17.4	24.3
Nonintegrated-Lightweight Papers				
o Lightweight	13.2	10.6	24.1	21.6
o Electrical	20.9	16.7	38.0	34.2
Nonintegrated-Filter and Nonwoven Papers	16.3	13.0	29.6	26.6
Nonintegrated-Paperboard	3.6	2.8	6.5	5.8

BPT EFFLUENT LIMITATIONS
NONCONTINUOUS DISCHARGERS

Subcategory	Annual Average (kg/kkg or lbs/1000 lbs)		Maximum 30-Day Average (mg/l)		Maximum Day (mg/l)	
	BOD5	TSS	BOD5	TSS	BOD5	TSS
Secondary Fibers Segment						
Paperboard From Wastepaper						
o Corrugating Medium Furnish	1.6	2.1	93	153	189	306
Wastepaper-Molded Products	1.3	3.2	27	66	51	122
Nonintegrated Segment						
Nonintegrated Fine Papers						
o Cotton Fiber Furnish	5.1	7.2	52	74	99	138
Nonintegrated-Lightweight Papers						
o Lightweight	7.4	6.0	65	52	118	106
o Electrical	11.6	9.5	65	52	118	106
Nonintegrated-Filter and Nonwoven Papers	9.1	7.4	65	52	118	106
Nonintegrated-Paperboard	2.0	1.6	65	52	118	106

off-the-machine coating where applicable) divided by the number of operating days during that year. Paper production shall be measured at the off-the-machine moisture content. Production shall be determined for each mill based on past production rates, present trends, or committed growth.

BPT effluent limitations were based on the anticipated performance of wastewater treatment technology (either primary clarification or biological treatment) applied to raw waste loads characteristic of the subcategory or on transfer of technology performance from another subcategory.

BAT

BAT limitations were established for the following toxic pollutants:

pentachlorophenol (PCP),
trichlorophenol (TCP), and
zinc.

BAT effluent limitations are shown in Table I-2 and I-3.

Effluent limitations for the control of pentachlorophenol and trichlorophenol were established for all subcategories. The technology basis of these limitations is the substitution of biocide formulations that do not contain pentachlorophenol and trichlorophenol for formulations containing these toxic pollutants.

BAT effluent limitations for zinc were established equal to BPT limitations for the three groundwood subcategories where zinc hydrosulfite has been used as a bleaching chemical. Limitations were based on the precipitation of zinc using lime, although the most likely technology employed to attain BAT is the substitution of sodium hydrosulfite for zinc hydrosulfite.

Limitations for BOD_5 and TSS are presented in kilograms of pollutant per 1,000 kilograms of production (lb/1,000 lbs). Production shall be defined as the annual off-the-machine production (including off-the-machine coating where applicable) divided by the number of operating days during that year. Paper production shall be measured at the off-the-machine moisture content whereas market pulp shall be measured in air-dry tons (10 percent moisture). Production shall be determined for each mill based on past production rates, present trends, or committed growth. For non-continuous dischargers, maximum day effluent concentrations shall apply.

NSPS

Pollutants regulated under NSPS include the conventional pollutants regulated under BPT (BOD_5, TSS, and pH) and the toxic pollutants regulated under BAT (pentachlorophenol, trichlorophenol, and zinc). NSPS effluent limitations are presented in Tables I-4, I-5, I-6, and I-7.

TABLE I-2

BAT EFFLUENT LIMITATIONS
(kg/kkg or lbs/1000 lbs)

	Maximum Day		
Subcategory	PCP[1]	TCP[2]	Zinc
Integrated Segment			
Dissolving Kraft	0.0025	0.016	NA
Market Bleached Kraft	0.0019	0.012	NA
BCT Bleached Kraft	0.0016	0.010	NA
Alkaline-Fine[3]	0.0014	0.0088	NA
Unbleached Kraft			
o Linerboard	0.00058	0.00053	NA
o Bag	0.00058	0.00053	NA
Semi-Chemical	0.0012	0.00043	NA
Unbleached Kraft and Semi-Chemical	0.00064	0.00059	NA
Dissolving Sulfite Pulp			
o Nitration	0.0030	0.019	NA
o Viscose	0.0030	0.019	NA
o Cellophane	0.0030	0.019	NA
o Acetate	0.0033	0.021	NA
Papergrade Sulfite[4]	*	*	*
Groundwood-Thermo-Mechanical	0.00097	0.00088	0.26
Groundwood-CMN Papers	0.0011	0.00099	0.30
Groundwood-Fine Papers	0.0010	0.00092	0.27
Secondary Fibers Segment			
Deink			
o Fine Papers	0.0030	0.0069	NA
o Tissue Papers	0.0030	0.0069	NA
o Newsprint	0.0030	0.0010	NA
Tissue From Wastepaper	0.0030	0.0011	NA
Paperboard From Wastepaper			
o Corrugating Medium Furnish	0.00087	0.00030	NA
o Noncorrugating Medium Furnish	0.00087	0.00030	NA
Wastepaper-Molded Products	0.0026	0.00088	NA
Builders' Paper and Roofing Felt	0.0017	0.00060	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	0.0018	0.00064	NA
o Cotton Fiber Furnish	0.0051	0.0018	NA
Nonintegrated-Tissue Papers	0.0028	0.00096	NA
Nonintegrated-Lightweight Papers			
o Lightweight	0.0059	0.0020	NA
o Electrical	0.0093	0.0032	NA
Nonintegrated-Filter and Nonwoven Papers	0.0072	0.0025	NA
Nonintegrated-Paperboard	0.0016	0.00054	NA

*Papergrade Sulfite Equations:

$PCP = 0.00058 \exp(0.017x)$
$TCP = 0.0036 \exp(0.017x)$
Where x equals percent sulfite pulp produced on-site in the final product.

[1] PCP = Pentachlorophenol

[2] TCP = Trichlorophenol

[3] Includes Fine Bleached Kraft and Soda subcategories.

[4] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

NA = Not applicable.

TABLE I-3

BAT EFFLUENT LIMITATIONS
NONCONTINUOUS DISCHARGERS
(concentrations mg/1)

	Maximum Day		
Subcategory	PCP[1]	TCP[2]	Zinc
Integrated Segment			
Dissolving Kraft	(0.011)(55.1)/Y	(0.068)(55.1)/Y	NA
Market Bleached Kraft	(0.011)(41.6)/Y	(0.068)(41.6)/Y	NA
BCT Bleached Kraft	(0.011)(35.4)/Y	(0.068)(35.4)/Y	NA
Alkaline-Fine[3]	(0.011)(30.9)/Y	(0.068)(30.9)/Y	NA
Unbleached Kraft			
o Linerboard	(0.011)(12.6)/Y	(0.010)(12.6)/Y	NA
o Bag	(0.011)(12.6)/Y	(0.010)(12.6)/Y	NA
Semi-Chemical	(0.029)(10.3)/Y	(0.010)(10.3)/Y	NA
Unbleached Kraft and Semi-Chemical	(0.011)(14.0)/Y	(0.010)(14.0)/Y	NA
Dissolving Sulfite Pulp			
o Nitration	(0.011)(66.0)/Y	(0.068)(66.0)/Y	NA
o Viscose	(0.011)(66.0)/Y	(0.068)(66.0)/Y	NA
o Cellophane	(0.011)(66.0)/Y	(0.068)(66.0)/Y	NA
o Acetate	(0.011)(72.7)/Y	(0.068)(72.7)/Y	NA
Papergrade Sulfite[4]	*	*	
Groundwood-Thermo-Mechanical	(0.011)(21.1)/Y	(0.010)(21.1)/Y	(3.0)(21.1)/Y
Groundwood-CMN Papers	(0.011)(23.8)/Y	(0.010)(23.8)/Y	(3.0)(23.8)/Y
Groundwood-Fine Papers	(0.011)(21.9)/Y	(0.010)(21.9)/Y	(3.0)(21.9)/Y
Secondary Fibers Segment			
Deink			
o Fine Papers	(0.029)(24.4)/Y	(0.068)(24.4)/Y	NA
o Tissue Papers	(0.029)(24.4)/Y	(0.068)(24.4)/Y	NA
o Newsprint	(0.029)(24.4)/Y	(0.010)(24.4)/Y	NA
Tissue From Wastepaper	(0.029)(25.2)/Y	(0.010)(25.2)/Y	NA
Paperboard From Wastepaper			
o Corrugating Medium Furnish	(0.029)(7.2)/Y	(0.010)(7.2)/Y	NA
o Noncorrugating Medium Furnish	(0.029)(7.2)/Y	(0.010)(7.2)/Y	NA
Wastepaper-Molded Products	(0.029)(21.1)/Y	(0.010)(21.1)/Y	NA
Builders' Paper and Roofing Felt	(0.029)(14.4)/Y	(0.010)(14.4)/Y	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	(0.029)(15.2)/Y	(0.010)(15.2)/Y	NA
o Cotton Fiber Furnish	(0.029)(42.3)/Y	(0.010)(42.3)/Y	NA
Nonintegrated-Tissue Papers	(0.029)(22.9)/Y	(0.010)(22.9)/Y	NA
Nonintegrated-Lightweight Papers			
o Lightweight	(0.029)(48.7)/Y	(0.010)(48.7)/Y	NA
o Electrical	(0.029)(76.9)/Y	(0.010)(76.9)/Y	NA
Nonintegrated-Filter and Nonwoven Papers	(0.029)(59.9)/Y	(0.010)(59.9)/Y	NA
Nonintegrated-Paperboard	(0.029)(12.9)/Y	(0.010)(12.9)/Y	NA

Y = Mill wastewater discharged per ton of product.
NA = Not Applicable.

*Papergrade Sulfite Equations:

PCP = ((0.011)(12.67) exp(0.017x))/Y
TCP = ((0.068)(12.67) exp(0.017x))/Y
Where x equals percent sulfite pulp produced on-site in the final product.

[1] PCP = Pentachlorophenol

[2] TCP = Trichlorophenol

[3] Includes Fine Bleached Kraft and Soda subcategories.

[4] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE I-4

NEW SOURCE PERFORMANCE STANDARDS CONVENTIONAL POLLUTANTS
(kg/kkg or lbs/1000 lbs)

Subcategory	Maximum 30-Day Average		Maximum Day	
	BOD5	TSS	BOD5	TSS
Integrated Segment				
Dissolving Kraft	8.4	14.3	15.6	27.3
Market Bleached Kraft	5.5	9.5	10.3	18.2
BCT Bleached Kraft	4.6	7.6	8.5	14.6
Alkaline-Fine[1]	3.1	4.8	5.7	9.1
Unbleached Kraft				
o Linerboard	1.8	3.0	3.4	5.8
o Bag	2.7	4.8	5.0	9.1
Semi-Chemical	1.6	3.0	3.0	5.8
Unbleached Kraft and Semi-Chemical	2.1	3.8	3.9	7.3
Dissolving Sulfite Pulp				
o Nitration	14.5	21.3	26.9	40.8
o Viscose	15.5	21.3	28.7	40.8
o Cellophane	16.8	21.3	31.2	40.8
o Acetate	21.4	21.5	39.6	41.1
Papergrade Sulfite[2]	*	*	*	*
Groundwood-Thermo-Mechanical	2.5	4.6	4.6	8.7
Groundwood-CMN Papers	2.5	3.8	4.6	7.3
Groundwood-Fine Papers	1.9	3.0	3.5	5.8
Secondary Fibers Segment				
Deink				
o Fine Papers	3.1	4.6	5.7	8.7
o Tissue Papers	5.2	6.8	9.6	13.1
o Newsprint	3.2	6.3	6.0	12.0
Tissue From Wastepaper	2.5	5.3	4.6	10.2
Paperboard From Wastepaper				
o Corrugating Medium Furnish	2.1	2.3	3.9	4.4
o Noncorrugating Medium Furnish	1.4	1.8	2.6	3.5
Wastepaper-Molded Products	1.1	2.3	2.1	4.4
Builders' Paper and Roofing Felt	0.94	1.4	1.7	2.7
Nonintegrated Segment				
Nonintegrated-Fine Papers				
o Wood Fiber Furnish	1.9	2.3	3.5	4.4
o Cotton Fiber Furnish	4.2	4.9	7.8	9.5
Nonintegrated-Tissue Papers	3.4	2.6	7.0	6.0
Nonintegrated-Lightweight Papers				
o Lightweight	6.7	5.2	13.7	12.0
o Electrical	11.7	9.2	24.1	21.1
Nonintegrated-Filter and Nonwoven Papers	8.3	6.6	17.1	15.0
Nonintegrated-Paperboard	1.9	1.5	4.0	3.5

pH-Within the range 5.0 to 9.0 at all times

---

*Papergrade Sulfite Equations:

Maximum 30-day average:

$$BOD5 = 2.36 \exp(0.017x)$$
$$TSS = 3.03 \exp(0.017x)$$

Maximum day:

$$BOD5 = 4.38 \exp(0.017x)$$
$$TSS = 5.81 \exp(0.017x)$$

Where x equals percent sulfite pulp produced on-site in the final product

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE I-5

NEW SOURCE PERFORMANCE STANDARDS
CONVENTIONAL POLLUTANTS
NONCONTINUOUS DISCHARGERS

Subcategory	Annual Average (kg/kkg or lbs/1000 lbs)		Maximum 30-Day Average (mg/l)		Maximum Day (mg/l)	
	BOD5	TSS	BOD5	TSS	BOD5	TSS
Integrated Segment						
Dissolving Kraft	4.4	7.5	40	68	74	129
Market Bleached Kraft	2.9	5.0	36	63	68	120
BCT Bleached Kraft	2.4	4.0	34	57	63	109
Alkaline-Fine[1]	1.6	2.5	29	45	53	85
Unbleached Kraft						
o Linerboard	0.96	1.6	47	79	87	151
o Bag	1.4	2.5	55	98	101	188
Semi-Chemical	0.84	1.6	52	97	97	186
Unbleached Kraft and Semi-Chemical	1.1	2.0	45	79	84	151
Dissolving Sulfite Pulp						
o Nitration	7.6	11.2	59	87	109	166
o Viscose	8.1	11.2	63	87	117	166
o Cellophane	8.8	11.2	68	87	127	166
o Acetate	11.2	11.3	78	79	145	151
Papergrade Sulfite[2]	*	*	62	80	115	153
Groundwood-Thermo-Mechanical	1.3	2.4	44	80	81	153
Groundwood-CMN Papers	1.3	2.0	34	54	63	104
Groundwood-Fine Papers	1.0	1.6	31	46	57	88
Secondary Fibers Segment						
Deink						
o Fine Papers	1.6	2.4	46	69	86	131
o Tissue Papers	2.7	3.6	62	84	116	162
o Newsprint	1.7	3.3	49	92	90	177
Tissue From Wastepaper	1.3	2.8	36	79	67	151
Paperboard From Wastepaper						
o Corrugating Medium Furnish	1.1	1.2	161	171	298	328
o Noncorrugating Medium Furnish	0.73	0.97	105	137	194	263
Wastepaper-Molded Products	0.60	1.2	48	92	89	176
Builders' Paper and Roofing Felt	0.49	0.73	83	122	154	234
Nonintegrated Segment						
Nonintegrated-Fine Papers						
o Wood Fiber Furnish	0.98	1.2	48	56	88	107
o Cotton Fiber Furnish	2.2	2.6	33	38	60	72
Nonintegrated-Tissue Papers	2.3	1.6	43	33	88	76
Nonintegrated-Lightweight Papers						
o Lightweight	4.5	3.2	42	33	87	76
o Electrical	7.9	5.6	42	33	87	76
Nonintegrated-Filter and Nonwoven Papers	5.6	4.0	42	33	87	76
Nonintegrated-Paperboard	1.3	0.94	42	33	87	76

pH-Within the range 5.0 to 9.0 at all times

---

*Papergrade Sulfite (See Equations in Table I-4).

BOD5 Long-Term Average = Maximum 30-day average ÷ 1.91
TSS Long-Term Average = Maximum 30-day average ÷ 1.90

[1] Includes Fine Bleached Kraft and Soda subcategories

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE I-6

NEW SOURCE PERFORMANCE STANDARDS
TOXIC POLLUTANTS
(kg/kkg or lbs/1000 lbs)

Subcategory	Maximum Day		
	PCP[1]	TCP[2]	Zinc
Integrated Segment			
Dissolving Kraft	0.0025	0.016	NA
Market Bleached Kraft	0.0019	0.012	NA
BCT Bleached Kraft	0.0016	0.010	NA
Alkaline-Fine[3]	0.0014	0.0088	NA
Unbleached Kraft			
o Linerboard	0.00058	0.00053	NA
o Bag	0.00058	0.00053	NA
Semi-Chemical	0.0012	0.00043	NA
Unbleached Kraft and Semi-Chemical	0.00064	0.00059	NA
Dissolving Sulfite Pulp			
o Nitration	0.0030	0.019	NA
o Viscose	0.0030	0.019	NA
o Cellophane	0.0030	0.019	NA
o Acetate	0.0033	0.021	NA
Papergrade Sulfite[4]	*	*	*
Groundwood-Thermo-Mechanical	0.00097	0.00088	0.17
Groundwood-CMN Papers	0.0011	0.00099	0.21
Groundwood-Fine Papers	0.0010	0.00092	0.19
Secondary Fibers Segment			
Deink			
o Fine Papers	0.0030	0.0069	NA
o Tissue Papers	0.0030	0.0069	NA
o Newsprint	0.0030	0.0010	NA
Tissue From Wastepaper	0.0030	0.0011	NA
Paperboard From Wastepaper			
o Corrugating Medium Furnish	0.00087	0.00030	NA
o Noncorrugating Medium Furnish	0.00087	0.00030	NA
Wastepaper-Molded Products	0.0026	0.00088	NA
Builders' Paper and Roofing Felt	0.0017	0.00060	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	0.0018	0.00064	NA
o Cotton Fiber Furnish	0.0051	0.0018	NA
Nonintegrated-Tissue Papers	0.0028	0.00096	NA
Nonintegrated-Lightweight Papers			
o Lightweight	0.0059	0.0020	NA
o Electrical	0.0093	0.0032	NA
Nonintegrated-Filter and Nonwoven Papers	0.0072	0.0025	NA
Nonintegrated-Paperboard	0.0016	0.00054	NA

---

*Papergrade Sulfite Equations:

$PCP = 0.00058 \exp(0.017x)$
$TCP = 0.0036 \exp(0.017x)$
Where x equals percent sulfite pulp produced on-site in the final product.

[1] PCP = Pentachlorophenol

[2] TCP = Trichlorophenol

[3] Includes Fine Bleached Kraft and Soda subcategories.

[4] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

NA = Not applicable.

TABLE I-7

NEW SOURCE PERFORMANCE STANDARDS
TOXIC POLLUTANTS
NONCONTINUOUS DISCHARGERS
(concentrations mg/l)

Subcategory	Maximum Day		
	PCP[1]	TCP[2]	Zinc
Integrated Segment			
Dissolving Kraft	(0.012)(50.7)/Y	(0.074)(50.7)/Y	NA
Market Bleached Kraft	(0.013)(36.6)/Y	(0.077)(36.6)/Y	NA
BCT Bleached Kraft	(0.012)(31.7)/Y	(0.076)(31.7)/Y	NA
Alkaline-Fine[3]	(0.014)(25.1)/Y	(0.084)(25.1)/Y	NA
Unbleached Kraft			
o Linerboard	(0.015)(9.4)/Y	(0.013)(9.4)/Y	NA
o Bag	(0.012)(11.4)/Y	(0.011)(11.4)/Y	NA
Semi-Chemical	(0.041)(7.3)/Y	(0.014)(7.3)/Y	NA
Unbleached Kraft and Semi-Chemical	(0.013)(11.5)/Y	(0.012)(11.5)/Y	NA
Dissolving Sulfite Pulp			
o Nitration	(0.012)(59.0)/Y	(0.076)(59.0)/Y	NA
o Viscose	(0.012)(59.0)/Y	(0.076)(59.0)/Y	NA
o Cellophane	(0.012)(59.0)/Y	(0.076)(59.0)/Y	NA
o Acetate	(0.012)(65.7)/Y	(0.075)(65.7)/Y	NA
Papergrade Sulfite[4]	*	*	
Groundwood-Thermo-Mechanical	(0.017)(13.8)/Y	(0.015)(13.8)/Y	(3.0)(13.8)/Y
Groundwood-CMN Papers	(0.016)(16.8)/Y	(0.014)(16.8)/Y	(3.0)(16.8)/Y
Groundwood-Fine Papers	(0.016)(15.4)/Y	(0.014)(15.4)/Y	(3.0)(15.4)/Y
Secondary Fibers Segment			
Deink			
o Fine Papers	(0.045)(15.9)/Y	(0.104)(15.9)/Y	NA
o Tissue Papers	(0.036)(19.5)/Y	(0.085)(19.5)/Y	NA
o Newsprint	(0.044)(16.2)/Y	(0.015)(16.2)/Y	NA
Tissue From Wastepaper	(0.045)(16.3)/Y	(0.015)(16.3)/Y	NA
Paperboard From Wastepaper			
o Corrugating Medium Furnish	(0.065)(3.2)/Y	(0.023)(3.2)/Y	NA
o Noncorrugating Medium Furnish	(0.065)(3.2)/Y	(0.023)(3.2)/Y	NA
Wastepaper-Molded Products	(0.107)(5.7)/Y	(0.037)(5.7)/Y	NA
Builders' Paper and Roofing Felt	(0.155)(2.7)/Y	(0.053)(2.7)/Y	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	(0.047)(9.4)/Y	(0.016)(9.4)/Y	NA
o Cotton Fiber Furnish	(0.039)(31.1)/Y	(0.014)(31.1)/Y	NA
Nonintegrated-Tissue Papers	(0.035)(19.1)/Y	(0.012)(19.1)/Y	NA
Nonintegrated-Lightweight Papers			
o Lightweight	(0.037)(38.2)/Y	(0.013)(38.2)/Y	NA
o Electrical	(0.033)(66.8)/Y	(0.012)(66.8)/Y	NA
Nonintegrated-Filter and Nonwoven Papers	(0.037)(47.5)/Y	(0.013)(47.5)/Y	NA
Nonintegrated-Paperboard	(0.033)(11.2)/Y	(0.012)(11.2)/Y	NA

Y = Mill wastewater discharged per ton of product.
NA = Not Applicable

*Papergrade Sulfite Equations:

PCP = ((0.015)(9.12) exp(0.017x))/Y
TCP = ((0.094)(9.12) exp(0.017x))/Y
Where x equals percent sulfite pulp produced on-site in the final product.

[1] PCP = Pentachlorophenol

[2] TCP = Trichlorophenol

[3] Includes Fine Bleached Kraft and Soda subcategories.

[4] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

The basis for NSPS for conventional pollutants is commonly employed production process control technology plus the application of end-of-pipe treatment of the type that formed the basis of BPT effluent limitations (i.e., biological treatment or primary treatment). The technology basis for control of toxic pollutants is identical to that which forms the basis of BAT effluent limitations.

Standards are presented in kilograms of pollutant per 1,000 kilograms of production (lb/1,000 lbs). The production basis shall be determined in the same manner as described under BAT.

PSES and PSNS

PSES and PSNS are established for the following toxic pollutants:

pentachlorophenol (PCP),
trichlorophenol (TCP), and
zinc.

PSES and PSNS are presented in Tables I-8 and I-9.

PSES and PSNS were based on chemical substitution to reduce substantially the discharge of PCP, TCP, and zinc. Pretreatment standards are needed because PCP, TCP, and zinc are known to pass through publicly owned treatment works (POTWs). Additionally, PSES and PSNS will minimize disposal problems associated with sludges containing zinc.

Pretreatment standards were established in terms of maximum allowable discharge concentrations (mg/l). They include a mathematical formula that accounts for flow differences to assure that the standards do not discourage the implementation of water conservation technologies at indirect discharging mills. Mass limitations (kg/kkg or lb/1000 lb of product) are also provided as guidance in cases where it is necessary to impose mass limitations for control of pollutants discharged from contributing pulp, paper, and paperboard mills to POTWs. The production basis shall be determined in the same manner as described under BAT.

IMPACT OF THE REGULATIONS

Existing Sources

BPT. Only the wastepaper-molded products subcategory is expected to incur BPT compliance costs. EPA anticipates that four mills in this subcategory will be required to spend a total of $6.01 million for capital investment and a total of $1.86 million annually (1978 dollars). Upon compliance with BPT effluent limitations for the wastepaper-molded products, nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories and for the cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory, EPA estimates that conventional pollutant removals from subcategory/subdivision raw waste discharges

TABLE I-8

PRETREATMENT STANDARDS FOR EXISTING SOURCES
(concentrations mg/l)

Subcategory	Maximum Day PCP[1]	Maximum Day TCP[2]	Maximum Day Zinc
Integrated Segment			
Dissolving Kraft	(0.011)(55.1)/Y	(0.082)(55.1)/Y	NA
Market Bleached Kraft	(0.011)(41.6)/Y	(0.082)(41.6)/Y	NA
BCT Bleached Kraft	(0.011)(35.4)/Y	(0.082)(35.4)/Y	NA
Alkaline-Fine[3]	(0.011)(30.9)/Y	(0.082)(30.9)/Y	NA
Unbleached Kraft			
o Linerboard	(0.011)(12.6)/Y	(0.010)(12.6)/Y	NA
o Bag	(0.011)(12.6)/Y	(0.010)(12.6)/Y	NA
Semi-Chemical	(0.032)(10.3)/Y	(0.010)(10.3)/Y	NA
Unbleached Kraft and Semi-Chemical	(0.011)(14.0)/Y	(0.010)(14.0)/Y	NA
Dissolving Sulfite Pulp			
o Nitration	(0.011)(66.0)/Y	(0.082)(66.0)/Y	NA
o Viscose	(0.011)(66.0)/Y	(0.082)(66.0)/Y	NA
o Cellophane	(0.011)(66.0)/Y	(0.082)(66.0)/Y	NA
o Acetate	(0.011)(72.7)/Y	(0.082)(72.7)/Y	NA
Papergrade Sulfite[4]	*	*	
Groundwood-Thermo-Mechanical	(0.011)(21.1)/Y	(0.010)(21.1)/Y	(3.0)(21.1)/Y
Groundwood-CMN Papers	(0.011)(23.8)/Y	(0.010)(23.8)/Y	(3.0)(23.8)/Y
Groundwood-Fine Papers	(0.011)(21.9)/Y	(0.010)(21.9)/Y	(3.0)(21.9)/Y
Secondary Fibers Segment			
Deink			
o Fine Papers	(0.032)(24.4)/Y	(0.082)(24.4)/Y	NA
o Tissue Papers	(0.032)(24.4)/Y	(0.082)(24.4)/Y	NA
o Newsprint	(0.032)(24.4)/Y	(0.010)(24.4)/Y	NA
Tissue From Wastepaper	(0.032)(25.2)/Y	(0.010)(25.2)/Y	NA
Paperboard From Wastepaper			
o Corrugating Medium Furnish	(0.032)(7.2)/Y	(0.010)(7.2)/Y	NA
o Noncorrugating Medium Furnish	(0.032)(7.2)/Y	(0.010)(7.2)/Y	NA
Wastepaper-Molded Products	(0.032)(21.1)/Y	(0.010)(21.1)/Y	NA
Builders' Paper and Roofing Felt	(0.032)(14.4)/Y	(0.010)(14.4)/Y	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	(0.032)(15.2)/Y	(0.010)(15.2)/Y	NA
o Cotton Fiber Furnish	(0.032)(42.3)/Y	(0.010)(42.3)/Y	NA
Nonintegrated-Tissue Papers	(0.032)(22.9)/Y	(0.010)(22.9)/Y	NA
Nonintegrated-Lightweight Papers			
o Lightweight	(0.032)(48.7)/Y	(0.010)(48.7)/Y	NA
o Electrical	(0.032)(76.9)/Y	(0.010)(76.9)/Y	NA
Nonintegrated-Filter and Nonwoven Papers	(0.032)(59.9)/Y	(0.010)(59.9)/Y	NA
Nonintegrated-Paperboard	(0.032)(12.9)/Y	(0.010)(12.9)/Y	NA

Y = Mill wastewater discharged per ton of product.
NA = Not Applicable

*Papergrade Sulfite Equations:

PCP = ((0.011)(12.67) exp(0.017x))/Y
TCP = ((0.082)(12.67) exp(0.017x))/Y
Where x equals percent sulfite pulp produced on-site in the final product.

[1] PCP = Pentachlorophenol

[2] TCP = Trichlorophenol

[3] Includes Fine Bleached Kraft and Soda subcategories.

[4] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE I-8 (continued)

PSES OPTIONAL MASS LIMITS
(kg/kkg or lb/1000 lbs)

Subcategory	Maximum Day		
	PCP[1]	TCP[2]	Zinc
Integrated Segment			
Dissolving Kraft	0.0025	0.019	NA
Market Bleached Kraft	0.0019	0.014	NA
BCT Bleached Kraft	0.0016	0.012	NA
Alkaline-Fine[3]	0.0014	0.011	NA
Unbleached Kraft			
o Linerboard	0.00058	0.00053	NA
o Bag	0.00058	0.00053	NA
Semi-Chemical	0.0014	0.00043	NA
Unbleached Kraft and Semi-Chemical	0.00064	0.00059	NA
Dissolving Sulfite Pulp			
o Nitration	0.0030	0.023	NA
o Viscose	0.0030	0.023	NA
o Cellophane	0.0030	0.023	NA
o Acetate	0.0033	0.025	NA
Papergrade Sulfite[4]	*	*	NA
Groundwood-Thermo-Mechanical	0.00097	0.00088	0.26
Groundwood-CMN Papers	0.0011	0.00099	0.30
Groundwood-Fine Papers	0.0010	0.00092	0.27
Secondary Fibers Segment			
Deink			
o Fine Papers	0.0033	0.0084	NA
o Tissue Papers	0.0033	0.0084	NA
o Newsprint	0.0033	0.0010	NA
Tissue From Wastepaper	0.0034	0.0011	NA
Paperboard From Wastepaper			
o Corrugating Medium Furnish	0.00096	0.00030	NA
o Noncorrugating Medium Furnish	0.00096	0.00030	NA
Wastepaper-Molded Products	0.0028	0.00088	NA
Builders' Paper and Roofing Felt	0.0019	0.00060	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	0.0020	0.00064	NA
o Cotton Fiber Furnish	0.0056	0.0018	NA
Nonintegrated-Tissue Papers	0.0031	0.00096	NA
Nonintegrated-Lightweight Papers			
o Lightweight	0.0065	0.0020	NA
o Electrical	0.010	0.0032	NA
Nonintegrated-Filter and Nonwoven Papers	0.0080	0.0025	NA
Nonintegrated-Paperboard	0.0017	0.00054	NA

Y = Mill wastewater discharged per ton of product.
NA = Not Applicable

*Papergrade Sulfite Equations:

PCP = 0.00058 exp(0.017x)
TCP = 0.0043 exp(0.017x)
Where x equals percent sulfite pulp produced on-site in the final product.

[1] PCP = Pentachlorophenol

[2] TCP = Trichlorophenol

[3] Includes Fine Bleached Kraft and Soda subcategories.

[4] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE I-9

PRETREATMENT STANDARDS FOR NEW SOURCES
(concentrations mg/l)

Subcategory	Maximum Day		
	PCP[1]	TCP[2]	Zinc
Integrated Segment			
Dissolving Kraft	(0.012)(50.7)/Y	(0.089)(50.7)/Y	NA
Market Bleached Kraft	(0.013)(36.6)/Y	(0.093)(36.6)/Y	NA
BCT Bleached Kraft	(0.012)(31.7)/Y	(0.092)(31.7)/Y	NA
Alkaline-Fine[3]	(0.014)(25.1)/Y	(0.101)(25.1)/Y	NA
Unbleached Kraft			
o Linerboard	(0.015)(9.4)/Y	(0.013)(9.4)/Y	NA
o Bag	(0.012)(11.4)/Y	(0.011)(11.4)/Y	NA
Semi-Chemical	(0.045)(7.3)/Y	(0.014)(7.3)/Y	NA
Unbleached Kraft and Semi-Chemical	(0.013)(11.5)/Y	(0.012)(11.5)/Y	NA
Dissolving Sulfite Pulp			
o Nitration	(0.012)(59.0)/Y	(0.092)(59.0)/Y	NA
o Viscose	(0.012)(59.0)/Y	(0.092)(59.0)/Y	NA
o Cellophane	(0.012)(59.0)/Y	(0.092)(59.0)/Y	NA
o Acetate	(0.012)(65.7)/Y	(0.091)(65.7)/Y	NA
Papergrade Sulfite[4]	*	*	
Groundwood-Thermo-Mechanical	(0.017)(13.8)/Y	(0.015)(13.8)/Y	(3.0)(13.8)/Y
Groundwood-CMN Papers	(0.016)(16.8)/Y	(0.014)(16.8)/Y	(3.0)(16.8)/Y
Groundwood-Fine Papers	(0.016)(15.4)/Y	(0.014)(15.4)/Y	(3.0)(15.4)/Y
Secondary Fibers Segment			
Deink			
o Fine Papers	(0.049)(15.9)/Y	(0.126)(15.9)/Y	NA
o Tissue Papers	(0.040)(19.5)/Y	(0.103)(19.5)/Y	NA
o Newsprint	(0.048)(16.2)/Y	(0.015)(16.2)/Y	NA
Tissue From Wastepaper	(0.049)(16.3)/Y	(0.015)(16.3)/Y	NA
Paperboard From Wastepaper			
o Corrugating Medium Furnish	(0.072)(3.2)/Y	(0.023)(3.2)/Y	NA
o Noncorrugating Medium Furnish	(0.072)(3.2)/Y	(0.023)(3.2)/Y	NA
Wastepaper-Molded Products	(0.118)(5.7)/Y	(0.037)(5.7)/Y	NA
Builders' Paper and Roofing Felt	(0.171)(2.7)/Y	(0.053)(2.7)/Y	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	(0.052)(9.4)/Y	(0.016)(9.4)/Y	NA
o Cotton Fiber Furnish	(0.044)(31.1)/Y	(0.014)(31.1)/Y	NA
Nonintegrated-Tissue Papers	(0.038)(19.1)/Y	(0.012)(19.1)/Y	NA
Nonintegrated-Lightweight Papers			
o Lightweight	(0.041)(38.2)/Y	(0.013)(38.2)/Y	NA
o Electrical	(0.037)(66.8)/Y	(0.012)(66.8)/Y	NA
Nonintegrated-Filter and Nonwoven Papers	(0.040)(47.5)/Y	(0.013)(47.5)/Y	NA
Nonintegrated-Paperboard	(0.037)(11.2)/Y	(0.012)(11.2)/Y	NA

Y = Mill wastewater discharged per ton of product.
NA = Not Applicable

*Papergrade Sulfite Equations:

PCP = ((0.015)(9.12) exp(0.017x))/Y
TCP = ((0.114)(9.12) exp(0.017x))/Y
Where x equals percent sulfite pulp produced on-site in the final product.

[1] PCP = Pentachlorophenol

[2] TCP = Trichlorophenol

[3] Includes Fine Bleached Kraft and Soda subcategories.

[4] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE I-9 (continued)

PSNS OPTIONAL MASS LIMITS
(kg/kkg or lb/1000 lbs)

Subcategory	Maximum Day		
	PCP[1]	TCP[2]	Zinc
Integrated Segment			
Dissolving Kraft	0.0025	0.019	NA
Market Bleached Kraft	0.0019	0.014	NA
BCT Bleached Kraft	0.0016	0.012	NA
Alkaline-Fine[3]	0.0014	0.011	NA
Unbleached Kraft			
o Linerboard	0.00058	0.00053	NA
o Bag	0.00058	0.00053	NA
Semi-Chemical	0.0014	0.00043	NA
Unbleached Kraft and Semi-Chemical	0.00064	0.00059	NA
Dissolving Sulfite Pulp			
o Nitration	0.0030	0.023	NA
o Viscose	0.0030	0.023	NA
o Cellophane	0.0030	0.023	NA
o Acetate	0.0033	0.025	NA
Papergrade Sulfite[4]	*	*	NA
Groundwood-Thermo-Mechanical	0.00097	0.00088	0.17
Groundwood-CMN Papers	0.0011	0.00099	0.21
Groundwood-Fine Papers	0.0010	0.00092	0.19
Secondary Fibers Segment			
Deink			
o Fine Papers	0.0033	0.0084	NA
o Tissue Papers	0.0033	0.0084	NA
o Newsprint	0.0033	0.0010	NA
Tissue From Wastepaper	0.0034	0.0011	NA
Paperboard From Wastepaper			
o Corrugating Medium Furnish	0.00096	0.00030	NA
o Noncorrugating Medium Furnish	0.00096	0.00030	NA
Wastepaper-Molded Products	0.0028	0.00088	NA
Builders' Paper and Roofing Felt	0.0019	0.00060	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	0.0020	0.00064	NA
o Cotton Fiber Furnish	0.0056	0.0018	NA
Nonintegrated-Tissue Papers	0.0031	0.00096	NA
Nonintegrated-Lightweight Papers			
o Lightweight	0.0065	0.0020	NA
o Electrical	0.010	0.0032	NA
Nonintegrated-Filter and Nonwoven Papers	0.0080	0.0025	NA
Nonintegrated-Paperboard	0.0017	0.00054	NA

Y = Mill wastewater discharged per ton of product.
NA = Not Applicable

*Papergrade Sulfite Equations:

PCP = 0.00058 exp(0.017x)
TCP = 0.0043 exp(0.017x)
Where x equals percent sulfite pulp produced on-site in the final product.

[1] PCP = Pentachlorophenol

[2] TCP = Trichlorophenol

[3] Includes Fine Bleached Kraft and Soda subcategories.

[4] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

will be 3.7 million kg/yr (8.1 million lbs/yr) of BOD5 and 14.2 million kg/yr (31.3 million lbs/yr) of TSS. EPA does not anticipate any additional pollutant removals from the corrugating medium furnish subdivision of the paperboard from wastepaper subcategory since the amended BPT effluent limitations are less stringent than the BPT effluent limitations established in 1974 for the entire paperboard from wastepaper subcategory.

EPA anticipates that compliance with BPT regulations will require the energy equivalent of 604 thousand liters (3800 barrels) of residual fuel oil per year which is 0.0017 percent of current industry usage. The Agency estimates that BPT regulations will result in the generation of 100 kkg (110 tons) of wastewater solids annually which is equal to 0.0042 percent of current solid waste generation in the industry. These wastewater solids have not been classified as hazardous under RCRA regulations.

BAT and PSES. No incremental costs are expected as a result of BAT and PSES regulations controlling pentachlorophenol and trichlorophenol. A survey of chemical manufacturers shows that no measurable increase in production costs can be expected through the use of substitute biocides that do not contain chlorophenolics. Therefore, the only incremental costs that might be incurred at these mills as a result of implementation of the BAT effluent limitations and PSES are associated with monitoring for PCP and TCP. However, since monitoring is not required where facilities certify that substitute chemicals are being used to control PCP and TCP and substitution is the technology basis of BAT limitations and PSES, EPA anticipates that monitoring will rarely be required.

Upon compliance with BAT effluent limitations and PSES, EPA estimates that about 17,100 kg/yr (37,600 lb/yr) of trichlorophenol and 11,640 kg/yr (25,600 lb/yr) of pentachlorophenol will be removed from industry wastewater discharges.

EPA estimates that attainment of BAT and PSES regulations controlling zinc will result in annual compliance costs of $23,300 (1978 dollars) at one indirect discharging mill. All other existing dischargers are in compliance with the zinc regulations. EPA estimates that the total quantity of zinc removed at the one indirect discharging groundwood mill where zinc hydrosulfite is used will be 20,000 kg/yr (44,000 lb/yr).

EPA anticipates that attainment of BAT effluent limitations and PSES will result in no increased energy use nor will it contribute to air pollution, noise generation, or solid waste generation.

New Sources

NSPS. The Agency anticipates that compliance with NSPS will result in incremental capital costs of $19.9 million and total annual costs of $6.9 million (1978 dollars) per year for the period between 1985 and 1990 based on the projected production growth rate. These costs are expected to cause an average price increase of 1.18 percent. Based on this price increase, EPA estimates that the annual industry growth rate will drop marginally from 3.0 to 2.9 percent. Substantial reductions of BOD_5, TSS, and zinc are ensured while discharges of trichlorophenol and pentachlorophenol resulting from the use of biocides will be virtually eliminated.

EPA projects that attainment of NSPS will result in an insignificant increase in solid waste generation and about a two percent increase in energy use compared to attainment of BPT effluent limitations.

PSNS. The technology basis for PSNS is identical to the technology basis of PSES; therefore, there is no incremental cost, economic impact, or non-water quality environmental impact attributable to PSNS.

SECTION II

INTRODUCTION

PURPOSE AND AUTHORITY

The Federal Water Pollution Control Act Amendments of 1972 (P.L. 92-500; the Act) established a comprehensive program to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (see section 101(a)). By July 1, 1977, existing industrial dischargers were required to achieve "effluent limitations requiring the application of the best practicable control technology currently available" (BPT) (see section 301(b)(1)(A)). By July 1, 1983, these dischargers were required to achieve "effluent limitations requiring the application of the best available technology economically achievable (BAT), which will result in reasonable further progress toward the national goal of eliminating the discharge of pollutants" (see section 301(b)(2)(A)). New industrial direct dischargers were required to comply with new source performance standards (NSPS), established under authority of section 306, based on best available demonstrated technology. New and existing dischargers to publicly owned treatment works (POTWs) were subject to pretreatment standards under sections 307(b) and (c) of the Act. While the requirements for direct dischargers were to be incorporated into National Pollutant Discharge Elimination System (NPDES) permits issued under section 402 of the Act, pretreatment standards were made enforceable directly against dischargers to POTWs (indirect dischargers).

Although section 402(a)(1) of the 1972 Act authorized the setting of requirements for direct dischargers on a case-by-case basis in the absence of regulations, Congress intended that, for the most part, control requirements would be based on regulations promulgated by the Administrator of EPA. Section 304(b) of the Act required the Administrator to promulgate regulations providing guidelines for effluent limitations setting forth the degree of effluent reduction attainable through the application of BPT and BAT. Moreover, sections 304(c) and 306 of the Act required promulgation of regulations for NSPS, and sections 304(f), 307(b), and 307(c) required promulgation of regulations for pretreatment standards. In addition to these regulations for designated industry categories, section 307(a) of the Act required the Administrator to promulgate effluent standards applicable to all dischargers of toxic pollutants. Finally, section 501(a) of the Act authorized the Administrator to prescribe any additional regulations "necessary to carry out his functions" under the Act.

The Agency was unable to promulgate many of these toxic pollutant regulations and guidelines within the time periods stated in the Act. In 1976, EPA was sued by several environmental groups and, in settlement of this lawsuit, EPA and the plaintiffs executed a "Settlement Agreement," which was approved by the Court. This

Agreement required EPA to develop a program and adhere to a schedule for promulgating, for 21 major industries, BAT effluent limitations guidelines, pretreatment standards, and new source performance standards for 65 toxic pollutants and classes of toxic pollutants (see Natural Resources Defense Council, Inc. v. Train, 8 ERC 2120 (D.D.C. 1976), modified, 12 ERC 1833 (D.D.C. 1979)).(1)(2)

On December 27, 1977, the President signed into law the Clean Water Act of 1977 (P.L. 95-217). Although this law makes several important changes in the Federal water pollution control program, its most significant feature is its incorporation into the Act of many of the basic elements of the Settlement Agreement program for toxic pollution control. Sections 301(b)(2)(A) and 301(b)(2)(C) of the Act now require the achievement by July 1, 1984, of effluent limitations requiring application of BAT for "toxic" pollutants, including the 65 "priority" pollutants and classes of pollutants which Congress declared "toxic" under section 307(a) of the Act. Likewise, EPA's programs for new source performance standards and pretreatment standards are now aimed principally at toxic pollutant controls. Moreover, to strengthen the toxics control program, Congress added a new section 304(e) to the Act, authorizing the Administrator to prescribe what have been termed "best management practices (BMPs)" to prevent the release of toxic pollutants from plant site runoff, spillage or leaks, sludge or waste disposal, and drainage from raw material storage associated with, or ancillary to, the manufacturing or treatment process.

The 1977 Amendments added Section 301(b)(2)(E) to the Act establishing "best conventional pollutant control technology" [BCT] for discharges of conventional pollutants from existing industrial point sources. Conventional pollutants are those defined in Section 304(a)(4) [biological oxygen demanding pollutants (i.e., BOD_5), total suspended solids (TSS), fecal coliform, and pH], and any additional pollutants defined by the Administrator as "conventional" [e.g., oil and grease; see 44 FR 44501, July 30, 1979].

BCT is not an additional limitation but replaces BAT for the control of conventional pollutants. In addition to other factors specified in section 304(b)(4)(B), the Act requires that BCT limitations be assessed in light of a two part "cost-reasonableness" test. American Paper Institute v. EPA, 660 F.2d 954 (4th Cir. 1981). The first test compares the cost for private industry to reduce its conventional pollutants with the costs to publicly owned treatment works (POTWs) for similar levels of reduction in their discharge of these pollutants. The second test examines the cost-effectiveness of additional industrial treatment beyond BPT. EPA must find that limitations are "reasonable" under both tests before establishing them as BCT. In no case may BCT be less stringent than BPT.

EPA published its methodology for carrying out the BCT analysis on August 29, 1979 (44 FR 50732). In the case mentioned above, the Court of Appeals ordered EPA to correct data errors underlying EPA's calculation of the first test, and to apply the second cost test.

(EPA had argued that a second cost test was not required.) The Agency has recently developed a revised BCT methodology (see 47 FR 49176, October 29, 1982).

For non-"toxic", non-"conventional" pollutants, sections 301(b)(2)(A) and (b)(2)(F) require achievement of BAT effluent limitations within three years after their establishment, or July 1, 1984, whichever is later, but not later than July 1, 1987.

STATUS OF THE EFFLUENT LIMITATIONS GUIDELINES

The effluent limitations guidelines program for the pulp, paper, and paperboard point source category has been active since 1972. In proposing and then promulgating effluent limitations and standards for the pulp, paper, and paperboard point source category, EPA conducted a two phase study. Phase I included certain portions of the industry where pulp bleaching is not employed. Phase II included the remaining portions of the point source category. Additionally, the Agency promulgated effluent limitations and standards for the builders' paper and board mills point source category.

The timing and status of the effluent limitations guidelines and standards that have been issued vary for the industry as shown in Table II-1. EPA promulgated BPT, BAT, NSPS, and PSNS for the builders' paper and roofing felt subcategory of the builders' paper and board mills point source category on May 9, 1974 (39 FR 16578; 40 CFR Part 431, Subpart A).(3) EPA promulgated BPT, BAT, NSPS, and PSNS for the unbleached kraft, sodium-based neutral sulfite semi-chemical, ammonia-based neutral sulfite semi-chemical, unbleached kraft-neutral sulfite semi-chemical (cross recovery), and paperboard from wastepaper subcategories of the pulp, paper, and paperboard point source category on May 29, 1974 (39 FR 18742; 40 CFR Part 430, Subparts A-E).(4) These five subcategories comprise Phase I. EPA promulgated BPT for the dissolving kraft, market bleached kraft, BCT (paperboard, coarse, and tissue) bleached kraft, fine bleached kraft, papergrade sulfite (blow pit wash), dissolving sulfite pulp, groundwood-chemi-mechanical, groundwood-thermo-mechanical, groundwood-CMN papers, groundwood-fine papers, soda, deink, nonintegrated-fine papers, nonintegrated-tissue papers, tissue from wastepaper, and papergrade sulfite (drum wash) subcategories of the pulp, paper, and paperboard point source category on January 6, 1977 (42 FR 1398; 40 CFR Part 430, Subparts F-U).(5) These 16 subcategories comprise Phase II.

Several industry members challenged the regulations promulgated on May 29, 1974, and January 6, 1977. These challenges were heard in the District of Columbia Circuit of the United States Court of Appeals. The promulgated regulations were upheld in their entirety with one exception. The Agency was ordered to reconsider the BPT BOD5 limitation for acetate grade pulp production in the dissolving sulfite pulp subcategory (Weyerhaeuser Company, et al. v. Costle, 590 F. 2nd 1011; D.C. Circuit 1978).(6) In response to this remand, the Agency proposed BPT regulations for acetate grade pulp production in the dissolving sulfite pulp subcategory on March 12, 1980 (45 FR

TABLE II-1
TIMING AND STATUS OF EFFLUENT LIMITATIONS

Subcategory/Regulation	Proposed Regulations					Promulgated Regulations					Comments
	BOD5	TSS	Zinc	pH	Color	BOD5	TSS	Zinc	pH	Color	
Dissolving Kraft											
Market Bleached Kraft											
BCT Bleached Kraft											
Fine Bleached Kraft											
Soda											
BPCTCA	2/19/76	2/19/76	-	2/19/76	-	1/6/77	1/6/77	-	1/6/77	-	
BATEA	2/19/76	2/19/76	-	2/19/76	2/19/76	-	-	-	-	-	
NSPS	2/19/76	2/19/76	-	2/19/76	-	-	-	-	-	-	
PSES & PSNS	-	-	-	-	-	-	-	-	-	-	
Groundwood-Chemi-Mechanical											
Groundwood-Thermo-Mechanical											
Groundwood-CMN Papers											
Groundwood-Fine Papers											
BPCTCA	2/19/76	2/19/76	2/19/76	2/19/76	-	1/6/77	1/6/77	1/6/77	1/6/77	-	
BATEA & NSPS	2/19/76	2/19/76	2/19/76	2/19/76	-	-	-	-	-	-	
PSES & PSNS	-	-	2/19/76	-	-	-	-	-	-	-	
Papergrade Sulfite (Blow Pit Wash)											
Papergrade Sulfite (Drum Wash)											
Dissolving Sulfite Pulp											BOD5 effluent limitation for the production of acetate grade pulp in the dissolving sulfite pulp subcategory was remanded by the Court of Appeals (9/78).
Deink											
Nonintegrated-Fine Papers											
Nonintegrated-Tissue Papers											
Tissue From Wastepaper											
BPCTCA	2/19/76	2/19/76	-	2/19/76	-	1/6/77	1/6/77	-	1/6/77	-	
BATEA & NSPS	2/19/76	2/19/76	-	2/19/76	-	-	-	-	-	-	
PSES & PSNS	-	-	-	-	-	-	-	-	-	-	
Unbleached Kraft											
Unbleached Kraft-NSSC											
BPCTCA	1/15/74	1/15/74	-	1/15/74	-	5/29/74	5/29/74	-	5/29/74	-	
BATEA & NSPS	1/15/74	1/15/74	-	1/15/74	1/15/74	5/29/74	5/29/74	-	5/29/74	5/29/74	
PSES & PSNS	-	-	-	-	-	-	-	-	-	-	
NSSC-Ammonia											
NSSC-Sodium											
BPCTCA	1/15/74	1/15/74	-	1/15/74	-	5/29/74	5/29/74	-	5/29/74	-	
BATEA	1/15/74	1/15/74	-	1/15/74	1/15/74	5/29/74	5/29/74	-	5/29/74	5/29/74	
NSPS	1/15/74	1/15/74	-	1/15/74	-	5/29/74	5/29/74	-	5/29/84	-	
PSES & PSNS	-	-	-	-	-	-	-	-	-	-	
Paperboard From Wastepaper											
BPCTCA, BATEA & NSPS	1/15/74	1/15/74	-	1/15/74	-	5/29/74	5/29/74	-	5/29/74	-	
PSES & PSNS	-	-	-	-	-	-	-	-	-	-	
Builders' Paper and Roofing Felt											
BPCTCA, BATEA & NSPS	1/14/74	1/14/74	-	1/14/74	-	5/9/74	5/9/74	-	5/9/74	-	BPCTCA, BATEA, & NSPS settleable solids limits were also promulgated.
PSES & PSNS	-	-	-	-	-	-	-	-	-	-	

15952).(7) EPA is currently assessing the costs and economic impacts associated with attainment of the proposed BPT limitation. Promulgation of this rule will occur at a later date.

EPA published proposed effluent limitations guidelines for BAT, BCT, NSPS, PSES, and PSNS for the pulp, paper, and paperboard and the builders' paper and board mills point source categories in the Federal Register on January 6, 1981 (46 FR 1430). (8) At the time of proposal, the subcategorization scheme was modified to include 25 subcategories in the pulp, paper, and paperboard industry.

SCOPE OF THIS RULEMAKING

The Clean Water Act of 1977 expanded the requirements for water pollution control in the pulp, paper, and paperboard industry. In EPA's initial rulemaking (May 1974 and January 1977), emphasis was placed on the achievement of BPT, BAT, and NSPS based on the control of familiar, primarily conventional pollutants, such as BOD, TSS, and pH. In 1977, EPA also proposed PSES based on compliance with general prohibitive waste provisions (42 FR 6476; 40 CFR Part 128).(9) By contrast, in this round of rulemaking, EPA's efforts are directed toward instituting BCT and BAT effluent limitations, new source performance standards, and pretreatment standards for existing and new sources that will result in reasonable further progress toward the national goal of eliminating the discharge of all pollutants.

In general, BCT represents the best control technology for conventional pollutants that is reasonable in cost and effluent reduction benefits. It replaces BAT for conventional pollutants. BAT represents, at a minimum, the best economically achievable performance in any industrial category or subcategory and, as a result of the Clean Water Act of 1977, emphasis has shifted to control of toxic and nonconventional pollutants. New source performance standards represent the best available demonstrated technology for control of all pollutants. Pretreatment standards for existing and new sources represent the best economically achievable performance for control of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of POTWs.

As a result of the Clean Water Act of 1977, all pollutants were divided into three categories: (a) conventional pollutants, (b) toxic pollutants, and (c) nonconventional pollutants. Included in the conventional pollutant category are 5-day biochemical oxygen demand (BOD_5), total suspended solids (TSS), pH, oil and grease, and fecal coliform. BOD_5, TSS, and pH are controlled for all subcategories of the pulp, paper, and paperboard industry by BPT and NSPS. EPA has recently proposed a revised BCT methodology in response to the American Paper Institute v. EPA decision mentioned previously. That rulemaking included a reproposal of BCT limitations for the pulp, paper, and paperboard industry. This document does not address the proposed BCT effluent limitations.

The toxic pollutants consist of the 65 classes of pollutants listed in the Settlement Agreement between EPA and the Natural Resources Defense Council, Inc. (NRDC).(1) These pollutants are controlled by BAT, NSPS, PSES, and PSNS. The list of 65 toxic pollutants and classes of toxic pollutants potentially includes thousands of specific pollutants; the expenditure of resources in government and private laboratories would be overwhelming if analyses were attempted for all of these pollutants. Therefore, in order to make the task more manageable, EPA selected 129 specific toxic pollutants for study in this rulemaking and other industry rulemakings.(10) The criteria for selection of these 129 pollutants included frequency of occurrence in water, chemical stability and structure, amount of the chemical produced, availability of chemical standards for measurement, and other factors. Since initiation of this rulemaking effort, three toxic pollutants were removed from the list of 129 toxic pollutants: dichlorodifluoromethane, trichlorofluoromethane, and bis-chloromethyl ether (46 FR 2266, January 8, 1981, and 46 FR 10723, February 4, 1981).

Nonconventional pollutants are those not included in one of the previous categories of pollutants. Discharge of these pollutants in this category may be industry-specific and, if warranted, may be regulated. In addition to industry-specific compounds, chemical oxygen demand (COD), ammonia, and color were nonconventional pollutants investigated by the Agency during this study. These pollutants are controlled by BAT and NSPS regulations, if appropriate.

SUMMARY OF METHODOLOGY

Introduction

EPA's implementation of the Act required a complex development program, described in this section and subsequent sections of this document. Initially, because in many cases no public or private agency had done so, EPA and its laboratories and consultants had to develop analytical methods for toxic pollutant detection and measurement, which are discussed below. EPA then gathered technical data about the industry, which are also summarized in this section. With these data, the Agency proceeded to develop final regulations.

First, EPA studied the pulp, paper, and paperboard industry to determine whether differences in raw materials, final products, manufacturing processes, equipment, age and size of manufacturing facilities, water use, wastewater constituents, or other factors required the development of separate effluent limitations and standards of performance for different segments (subcategories) of the industry. This study required the identification of raw waste and treated effluent characteristics, including: a) the sources and volume of water used, the manufacturing processes employed, and the sources of pollutants and wastewaters within the plant, and b) the constituents of wastewaters, including toxic pollutants. EPA then identified the constituents of wastewaters which should be considered for effluent limitations guidelines and standards of performance.

Next, EPA identified several distinct control and treatment technologies, including both in-plant and end-of-pipe technologies, which are in use or capable of being used to control or treat pulp, paper, and paperboard industry wastewaters. The Agency compiled and analyzed historical and newly generated data on the effluent quality resulting from the application of these technologies. The long-term performance, operational limitations, and reliability of each of the treatment and control technologies were also identified. In addition, EPA considered the non-water quality environmental impacts of these technologies, including impacts on air quality, solid waste generation, and energy requirements.

The Agency then estimated the costs of each control and treatment technology for the various industry subcategories from unit cost curves developed by standard engineering analysis as applied to the specific pulp, paper, and paperboard wastewater characteristics. EPA derived unit process costs from model plant characteristics (production and flow) applied to each treatment process unit cost curve (i.e., activated sludge, chemically assisted clarification/sedimentation, granular activated carbon adsorption, mixed media filtration). These unit process costs were combined to yield total cost at each treatment level. The Agency confirmed the reasonableness of this methodology by comparing EPA cost estimates to treatment system costs supplied by the industry.

Upon consideration of these factors, as more fully described below, EPA identified various control and treatment technologies as BPT, BAT, NSPS, PSES, and PSNS. The final regulations, however, do not require the installation of any particular technology. Rather, they require achievement of effluent limitations representative of the proper application of these technologies or equivalent technologies. A mill's existing controls should be fully evaluated, and existing treatment systems fully optimized, before commitment to any new or additional end-of-pipe treatment technology.

To assemble the necessary data to allow promulgation of BPT effluent limitations, pretreatment standards, and NSPS for the pulp, paper, and paperboard industry, twelve major tasks were completed, including:

1. evaluation of existing data,
2. development of a data request program to obtain new information,
3. completion of a screening program,
4. completion of an industry profile and a review of industry subcategorization
5. completion of a verification program,
6. analysis of data from a long-term sampling program,

7. development of a program for collection and analysis of discharge monitoring data,

8. analysis of information gathered during the supplemental data acquisition program,

9. evaluation of PCB data,

10. review of data obtained from industry comments on the proposed regulation,

11. determination and analysis of appropriate treatment and control alternatives, and

12. development and analysis of cost and energy data.

EPA completed several of the above-mentioned tasks to allow the Agency to respond fully to comments on the proposed rules. EPA obtained additional data on the presence and variability of toxic pollutants in raw wastes and treated effluents by conducting a long-term (23 week) sampling and analysis program at a deink and a fine bleached kraft mill (Task 6). The Agency used data for the deink mill to support the PCB effluent limitations and NSPS that EPA proposed concurrent with the final regulations discussed in this document. The data for the fine bleached kraft mill were gathered to investigate further the variability of biological treatment in removing chloroform; however, as described herein, EPA decided to withdraw the proposed chloroform limitations.

EPA also obtained (1) discharge monitoring reports (DMRs) from Regional and State permitting authorities to update its records to include the most recent available data (Task 7) and (2) additional conventional pollutant data under the authority of section 308 of the Act to broaden and update our existing data base on the variability associated with wastewater treatment systems (Task 8). EPA used these data, as well as data on PCP and TCP that became available during the PCB/chloroform sampling, to verify the accuracy of the analyses done prior to proposal.

Industry, in some cases, provided comments on our proposed regulations that included effluent data on the discharge of toxic pollutants. In many cases, data were provided in a format that did not allow for proper analysis by the Agency. In those instances, EPA requested additional information in a format that would allow the Agency to include the data when developing the final regulations (Task 10).

Existing Data Evaluation

To assess existing data on pollutants and their control/reduction in the pulp, paper, and paperboard industry, several data sources were investigated, including a) the EPA's administrative record, b) information acquired from State regulatory agencies, EPA regional offices, and research facilities, and c) the literature.

Administrative Record. EPA reviewed the administrative records for the previous effluent limitations guidelines studies of the pulp, paper, and paperboard and the builders' paper and board mills point source categories for information on:

- the use of chemical additives,
- the use or suspected presence of the 129 toxic pollutants,
- the use or suspected presence of other (nonconventional) pollutants,
- available production process controls, and
- available effluent treatment techologies.

Regulatory Agencies and Research Facilities. During the initial months of the project, EPA determined that the State regulatory agencies and the EPA regional offices had very few past or ongoing projects that related to the toxic pollutants and the pulp, paper, and paperboard industry. The State of Wisconsin and EPA, however, had recently completed a study that deals with toxic pollutants found in the discharges from pulp, paper, and paperboard mills.(10) Results show that pulp, paper, and paperboard mill effluents contained numerous organic compounds which are not on EPA's list of 129 specific toxic pollutants.

In addition, representatives of several research and other facilities were contacted to obtain all available information on ongoing or unpublished work. Facilities contacted included:

University of Washington
College of Forest Resources
Seattle, Washington

Washington Department of
Fisheries Laboratory
Quilcene, Washington

Simpson Paper Company
Anderson, California

University of California Forest
Products Laboratory
Richmond, California

State University of New York
College of Environmental Science
and Forestry
Syracuse, New York

B.C. Research, Inc.
Vancouver, B.C.

Institute of Paper Chemistry
Appleton, Wisconsin

Forest Products Laboratory
Madison, Wisconsin

University of Toronto
Toronto, Canada

Pulp & Paper Research Institute
of Canda
Point Claire, Quebec

HSA Reactors Ltd.
Toronto, Canada

Lundberg Ahlen, Inc.
Richmond (Vancouver), Canada

The Literature. The Agency reviewed data available in the literature to identify which of the 129 toxic pollutants, if any, might be present in the wastewaters discharged from pulp, paper, and paperboard mills. This review also included a similar investigation of other, nonconventional, pollutants. Specifically, the materials, chemicals, and processes that might contribute to the discharge of both toxic and nonconventional pollutants were identified. Also, data were sought on technologies available to remove or control the 129 toxic pollutants and nonconventional pollutants under investigation. Several automated document data bases were searched to identify relevant literature that included:

- The Department of Commerce/National Oceanic and Atmospheric Administration's Environmental Data Service (Environmental Data Index - ENDEX and the Oceanic Atmospheric Scientific Information System - OASIS),
- University microfilm's xerographic dissertation abstract service (DATRIX II),
- Environment Canada's Water Resources Document Reference Center through Canada's Inland Waters Directorate (WATDOC), and
- The Institute of Paper Chemistry's Abstract Service (PAPERCHEM and Chemical Abstracts).

Through these services, over one million articles/papers and 3,500 environmental data files were identified. Those that appeared to be relevant were obtained and reviewed.

Also, several other summary documents were reviewed, including a) work conducted by the Pulp and Paper Research Institute of Canada, b) a report entitled, "Multi-Media Pollution Assessment in Pulp, Paper, and Other Wood Products Industry," prepared for the U.S. EPA by Battelle-Columbus Laboratories, December 1976, (11), c) the U.S. EPA's Office of Research and Development Publication Summary (December 1976, Cincinnati, Ohio), d) Environment Canada's Publication Summary of work conducted under the Canadian Pollution Abatement Research Program, March 1977 and March 1978, and e) "A position paper documenting the toxicity of pulp and paper mill discharges and recommending regulatory guidelines and measurement procedures," prepared for the Canadian Pulp & Paper Association by B.C. Research, Vancouver, B.C., Canada, December 1974.

Through these reviews, several compounds on the toxic pollutant list, as well as certain nonconventional pollutants known to be toxic to aquatic organisms, were noted as being present in the discharge from pulp, paper, and paperboard mills.(12) As a result of this review, 14 additional compounds were added to the list of pollutants to be studied including xylene, 4 resin acids, 3 fatty acids, and 6 bleach plant derivatives.

Data Request Program

To develop an up-to-date profile of the pulp, paper, and paperboard industry, data from previous effluent limitations guidelines studies were supplemented by undertaking a new data request program. Information was collected on age and size of facilities, raw material usage, production processes employed, wastewater characteristics, and methods of wastewater control and treatment.

Data Request Development. The data request program was developed with considerable input from industry representatives. It was initially envisioned that a separate survey form would be developed for each of eight basic types of manufacturing facilities: kraft and soda, sulfite, groundwood, deink, NSSC and CMP/TMP, paperboard from wastepaper, builders' paper mills, and nonintegrated mills. After numerous discussions with industry representatives, it was decided that only two survey forms would be developed for the basic types of manufacturing facilities:(13)

(1) Multiple Pulping/Integrated Mills, including

Kraft and Soda Mills
Sulfite Mills
Groundwood Mills
Deink Mills
NSSC and CMP/TMP Mills
Paperboard from Wastepaper Mills
Builders' Paper Mills

(2) Nonintegrated Mills, including production of

Fine Papers
Coarse Papers
Paperboard
Tissue Papers and
Other Products

The data request program was developed through coordination with the American Paper Institute (API) BAT Task Group. This industry committee was formed to interact with EPA during the BATEA review project and included representatives from individual companies and technical associations. The committee participated in the review and development of the survey forms and had considerable input into their content. EPA made revisions to the data request forms in accordance with discussions at three API BAT Task Group meetings.

The final data request forms included two parts: Part I requested information required for selecting mills for the verification sampling program; Part II requested information needed for a complete assessment of the industry profile and subcategorization scheme. When EPA representatives sought input from the industry task group on the proper number of mills that should receive a data request form, representatives of both large and small mills recommended 100 percent coverage of the industry. Therefore, under the authority of section 308 of the Act, data requests were sent to representatives of all known operating pulp, paper, and paperboard mills during the last week in September of 1977. The responses to Parts I and II were to be completed and returned to the Agency in mid-November of 1977 and early January of 1978, respectively.

Because the data request forms were complex, representatives of the National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI) requested that representatives of the EPA attend a meeting on October 6, 1977, in Chicago, Illinois, to answer questions from mill representatives about the forms. As a result of this meeting, an errata sheet was prepared and distributed to representatives of mills who had received the data request forms.(14)

Throughout the response period industry representatives asked numerous questions related to production information, raw material utilization, process chemicals, and process description. Agency personnel or representatives continually worked with industry to ensure that questions were correctly interpreted.

Representatives of the surveyed mills could request that EPA hold certain information confidential. They were also allowed to send copies of their completed forms to the NCASI and, where this was done, EPA representatives were able to communicate with representatives of NCASI regarding individual survey responses.

Data Processing System. Since EPA expected to receive 700 responses to the data request, the Agency developed a multi-phase procedure for receiving and processing responses. The first step in the processing system was the development of mill codes to ensure anonymity and to facilitate computer analysis of data obtained. Other steps included data input, data verification, and data processing.

As responses to the data requests were received, they were dated and logged into the data processing system. Since nonstandard and lengthy responses were anticipated, the survey forms were manually reviewed before input into the data processing system. This review ensured consistency in the data input format and reasonableness of responses.

In the review for reasonableness, numeric responses totally out of line with expected values were either reconciled with other responses relating to a specific mill request or the respondent was contacted for clarification. The same procedure was followed for responses which indicated a misunderstanding or misinterpretation of a question. It was necessary to contact representatives of approximately 35 percent of the mills from which data request forms were received to verify responses.

Responses were stored as they appeared on the original survey form or in coded form. If a question requiring a numeric response (i.e., year or quantity) was answered but included a written explanation, a code was inserted in the data base that indicated the presence of additional information. A similar code was used to indicate an answer that had been calculated by the reviewing engineer (these answers usually consisted of conversions to standard units). Codes for "unknown" or "not available" information were also utilized as appropriate. All codes and notes indicating additional information were retrievable during the data analysis phase.

Data Verification and Editing Techniques. Information contained in the data files was verified by comparing the printed output file copy with the original data request responses. Data files were updated according to the verified printouts.

Response to Data Request. The response rate for both the integrated and nonintegrated data request forms was good. The total number of operating mills completing forms and the percentage of the total operating mills that this represented are shown in Table II-2.

An additional summary was prepared showing facilities that did not respond to the data request or were not sent a survey form. A profile of these mills was developed with respect to raw material usage, manufacturing processes, products manufactured, wastewater characteristics, and the type of effluent discharge. This profile was prepared by utilizing readily available sources, including representatives of the facilities, EPA Regional personnel, State permitting officials, existing files, literature, and industry directories. These new data were incorporated into the overall industry profile.

Screening Program

As a result of the Settlement Agreement, the EPA was to determine the presence or absence of 65 toxic pollutants or classes of pollutants in industrial effluent discharges. Prior to the technical studies required, EPA expanded the list of "priority pollutants" to include 129 specific toxic pollutants.(10) Based on the information gathered in the literature review, EPA identified an additional 14 nonconventional pollutants of concern specific to the pulp, paper, and paperboard industry.

The screening program was established to determine the presence or absence of the 129 toxic and 14 additional nonconventional pollutants listed in Table II-3 in pulp, paper, and paperboard wastewaters. The analysis procedures used during screening, outlined in Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants (EPA, Cincinnati, Ohio, April, 1977) and Analysis Procedures for Screening of Pulp, Paper, and Paperboard Effluents for Nonconventional Pollutants (EPA, Washington, D.C., December, 1980), allow for calculation of the approximate quantity of toxic and nonconventional pollutants present in wastewaters. (15)(16) Specific criteria were developed for selecting sampling mills so that these facilities would be representative of the entire pulp, paper, and paperboard industry.

TABLE II-2

RESPONSE TO DATA REQUEST

Number of operating mills sent surveys:	642
Number of operating mills returning surveys:	610
Percentage response:	95%
Method of Discharge - Responding Operating Mills	
Direct Dischargers:	319
Indirect Dischargers:	221
Combined Indirect and Direct Dischargers:	18
Self-Contained:	52

TABLE II-3

TOXIC AND ADDITIONAL NONCONVENTIONAL POLLUTANTS UNDER INVESTIGATION IN THE SCREENING PROGRAM

1. *acenaphthene
2. *acrolein
3. *acrylonitrile
4. *benzene
5. *benzidine
6. *carbon tetrachloride
(tetrachloromethane)

*CHLORINATED BENZENES (other than DICHLOROBENZENES)

7. chlorobenezene
8. 1,2,4-trichlorobenzene
9. hexachlorobenzene

*CHLORINATED ETHANES

10. 1,2-dichloroethane
11. 1,1,1-trichloroethane
12. hexachloroethane
13. 1,1-dichloroethane
14. 1,1,2-trichloroethane
15. 1,1,2,2-tetrachloroethane
16. chloroethane

*CHLOROALKYL ETHERS

17. bis(chloromethyl) ether
18. bis(2-chloroethyl) ether
19. 2-chloroethyl vinyl ether (mixed)

*CHLORINATED NAPHTHALENE

20. 2-chloronaphthalene

*CHLORINATED PHENOLS (Other than those listed elsewhere; includes chlorinated cresols

21. 2,4,6-trichlorophenol
22. parachlorometa cresol
23. *chloroform (trichloromethane)
24. *2-chlorophenol

*DICHLOROBENZENES

25. 1,2-dichlorobenzene
26. 1,3-dichlorobenzene
27. 1,4-dichlorobenzene

*DICHLOROBENZIDINE

28. 3,3'-dichlorobenzidine

*DICHLOROETHYLENES

29. 1,1-dichloroethylene
30. 1,2-trans-dichloroethylene
31. *2,4-dichlorophenol

*DICHLOROPROPANE AND DICHLOROPROPENE

32. 1,2-dichloropropane
33. 1,3-dichloropropylene (1,3-dichloropropene)

34. *2,4-dimethylphenol

*DINITROTOLUENE

35. 2,4-dinitrotoluene
36. 2,6-dinitrotoluene

37. *1,2-diphenylhydrazine
38. *ethylbenzene
39. *fluoranthene

*Specific compounds and chemical classes as listed in the consent decree.

TABLE II-3 (Continued)

*HALOETHERS (other than those listed elsewhere)

40. 4-chlorophenyl phenyl ether
41. 4-bromophenyl phenyl ether
42. bis(2-chloroisopropyl) ether
43. bis(2-chloroethoxy) methane

*HALOMETHANES (other than those listed elsewhere)

44. methylene chloride (dichloromethane)
45. methyl chloride (chloromethane)
46. methyl bromide (bromomethane)
47. bromoform (tribromomethane)
48. dichlorobromomethane
49. trichlorofluoromethane
50. dichlorodifluoromethane
51. chlorodibromomethane

52. *hexachlorobutadiene
53. *hexachlorocyclopentadiene
54. *isophorone
55. *naphthalene
56. *nitrobenzene

*NITROPHENOLS

57. 2-nitrophenol
58. 4-nitrophenol
59. *2,4-dinitrophenol
60. 4,6-dinitro-o-cresol

*NITROSAMINES

61. N-nitrosodimethylamine
62. N-nitrosodiphenylamine
63. N-nitrosodi-n-propylamine

64. *pentachlorophenol
65. *phenol

*PHTHALATE ESTERS

66. bis(2-ethylhexyl) phthalate
67. butyl benzyl phthalate
68. di-n-butyl phthalate
69. di-n-octyl phthalate
70. diethyl phthalate
71. dimethyl phthalate

*POLYNUCLEAR AROMATIC HYDROCARBONS

72. benzo[a]anthracene (1,2-benzanthracene)
73. benzo[a]pyrene (3,4-benzopyrene)
74. 3,4-benzo fluoranthene
75. benzo[k]fluoranthene (11,12-benzo fluoranthene)
76. chrysene
77. acenaphthylene
78. anthracene
79. benzo[ghi]perylene (1,12-benzoperylene)
80. fluorene
81. phenanthrene
82. dibenzo[a,h]anthracene (1,2,5,6-dibenzanthracene)
83. indeno[1,2,3-cd]pyrene (2,3-o-phenylenepyrene)
84. pyrene

85. *tetrachloroethylene
86. *toluene
87. *trichloroethylene
88. *vinyl chloride (chloroethylene)

PESTICIDES AND METABOLITES

89. *aldrin
90. *dieldrin
91. *chlordane (technical mixture & metabolites)

*Specific compounds and chemical classes as listed in the consent decree.

TABLE II-3 (Continued)

*DDT AND METABOLITES

92. 4,4'-DDT
93. 4,4'-DDE (p,p'-DDX)
94. 4,4'-DDD (p,p'-TDE)

*ENDOSULFAN AND METABOLITES

95. α-endosulfan
96. β-endosulfan
97. endosulfan sulfate

*ENDRIN AND METABOLITES

98. endrin
99. endrin aldehyde

*HEPTACHLOR AND METABOLITES

100. heptachlor
101. heptachlor epoxide

*HEXACHLOROCYCLOHEXANE (all isomers)

102. α-BHC
103. β-BHC
104. γ-BHC (lindane)
105. δ-BHC

*POLYCHLORINATED BIPHENYLS (PCB's)

106. PCB-1242 (Arochlor 1242)
107. PCB-1254 (Arochlor 1254)
108. PCB-1221 (Arochlor 1221)
109. PCB-1232 (Arochlor 1232)
110. PCB-1248 (Arochlor 1248)
111. PCB-1260 (Arochlor 1260)
112. PCB-1016 (Arochlor 1016)

113. *toxaphene
114. *antimony (total)
115. *arsenic (total)
116. *asbestos (fibrous)
117. *beryllium (total)
118. *cadmium (total)
119. *chromium (total)
120. *copper (total)
121. *cyanide (total)
122. *lead (total)
123. *mercury (total)
124. *nickel (total)
125. *selenium (total)
126. *silver (total)
127. *thallium (total)
128. *zinc (total)
129. 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)

ADDITIONAL NONCONVENTIONAL POLLUTANTS

130. abietic acid
131. dehydroabietic acid
132. isopimaric acid
133. primaric acid
134. oleic acid
135. linoleic acid
136. linolenic acid
137. 9,10-epoxystearic acid
138. 9,10-dichlorostearic acid
139. monochlorodehydroabietic acid
140. dichlorodehydroabietic acid
141. 3,4,5-trichloroguaiacol
142. tetrachloroguaiacol
143. xylenes

*Specific compounds and chemical classes as listed in the consent decree.

Mill Selection for Sampling. A primary goal in mill selection was to group mill types so that selected mills would be representative of the entire pulp, paper, and paperboard industry. The 15 mill groupings developed are presented in Table II-4.

EPA determined that one mill representative of each of these groupings would be sampled during the screening program. To ensure that mills would be representative of current industry practice, the following four criteria were used to select mills:

- the mill should be a direct discharging mill to obtain the maximum amount of data (both raw waste and treated effluent data),
- a biological treatment system should be employed at the mill if BPT limitations were based on biological treatment; if BPT limitations were based on primary treatment, the system could be a primary treatment system,
- the flow and BOD_5 raw wastewater characteristics of the mill should approximate the raw wastewater levels that formed the basis of BPT effluent limitations for the specific mill grouping (to ensure that the selected mill would be representative of the industry grouping), and
- the manufacturing process should be representative of the respective mill grouping.

Based upon these criteria, mills were selected for 11 of the 15 industry groupings. Table II-5 presents a summary of the treatment systems employed, and the raw waste characteristics at screening program mills. Information is also presented on raw waste loadings used in the development of BPT effluent limitations for the 11 mill groupings. Raw wastewater characteristics at some of the selected mills did not approximate the raw wastewater characteristics that formed the basis of BPT effluent limitations as closely as other mills in the grouping. EPA selected these mills for inclusion in the screening program because they satisfied all four selection criteria better than other mills.

Because of insufficient data, representative mills could not be selected for the following industry groupings:

Nonintegrated-Coarse Papers,
Nonintegrated-Specialty Papers (I),
Nonintegrated-Specialty Papers (II), and
Builders' Paper and Roofing Felt.

For these industry groupings, EPA recognized that additional data would become available as a result of the data request program. Therefore, screening program visits to facilities in additional industry groupings were delayed until these data could be obtained and evaluated.

TABLE II-4

SUBCATEGORY GROUPS SELECTED FOR SCREENING PROGRAM

*Bleached Kraft	Fine Papers
*Bleached Kraft	BCT/Market Pulp/Dissolving
*Unbleached Kraft	
*Unbleached Kraft/Neutral Sulfite Semi-Chemical (Cross Recovery)	
*Neutral Sulfite Semi-Chemical	
*Sulfite	
*Groundwood	Fine Papers
*Deink	
*Nonintegrated	Fine Papers
*Nonintegrated	Tissue Papers
Nonintegrated	Coarse Papers
Nonintegrated	Specialty Papers (I)
Nonintegrated	Specialty Papers (II)
*Paperboard from Wastepaper	
Builders' Paper and Roofing Felt	

*Screened during initial contractor screening studies.

TABLE II-5

SUMMARY OF TREATMENT TYPE AND PERCENT DIFFERENCES CONTRACTOR SCREENING FOR MILLS VERSUS RAW WASTE LOAD BASIS OF BPT

Subcategory	Treatment Type	Percent from BPT RWL	
		Flow	BOD5
Fine Bleached Kraft	ASB w/ Polishing Pond	+ 32%	+ 11%
Bleached Kraft - BCT/Market	ASB w/ Polishing Pond	+ 3%	+ 16%
Unbleached Kraft	ASB	- 25%	- 21%
Unbleached Kraft/Neutral Sulfite Semi-Chemical (Cross Recovery)	ASB	- 5%	- 13%
Neutral Sulfite Semi-Chemical	ASB w/ Polishing Pond	0%	+ 40%
Sulfite	ASB	+ 14%	- 6%
Groundwood	Activated Sludge	+ 9%	- 11%
Deink	Activated Sludge	- 14%	- 29%
Nonintegrated - Fine	ASB	+ 9%	+ 4%
Nonintegrated - Tissue	Primary Treatment	+ 16%	+ 32%
Paperboard from Wastepaper	Activated Sludge	- 7%	- 14%

After completion of the 11 sampling visits, funding for this project was depleted due to delays of supplemental appropriations from Congress. Therefore, the screening program was delayed until the necessary funding could be allocated.

Supplemental Screening Surveys. In addition to the initial screening program surveys, EPA Regional Surveillance and Analysis field teams surveyed an additional 47 mills to provide supplemental information. The analytical procedures used in the analysis of samples were those detailed in Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants (EPA, Cincinnati, Ohio, April, 1977).(15) Therefore, the results are comparable to those resulting from the 11 contractor screening surveys.

As explained later in this section, at a total of 17 mills sampled during the verification program, processes were employed that were characteristic of the four mill groupings not included in the initial contractor screening program. These mills were included in a supplemental screening effort during the verification program.

Figure II-1 shows the location of the 58 mills sampled as part of the screening program.

Sampling Program. Three sample locations for each mill were chosen for the sampling program: a) the raw process water prior to water treatment, b) the raw wastewater discharge to the wastewater treatment system, and c) the final effluent from the wastewater treatment system(s).

The raw process water was selected to obtain background concentration levels for any toxic pollutants present in the water supply prior to use at the mill. The raw wastewater was sampled to provide data on the toxic pollutants attributable to the industrial process that were being discharged to the wastewater treatment system. The final effluent was sampled to determine the presence and quantity of toxic pollutants remaining after wastewater treatment.

Prior to the sampling program, a "Screening Program Work Booklet" detailing the specific procedures of the program was prepared.(17) These procedures were derived from and are consistent with Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants (EPA, Cincinnati, Ohio, April, 1977). (15) The screening surveys conducted by the contractor during the initial screening program included collecting both composite and grab samples during the 3-day survey. Composite sampling was conducted for a period of 72 consecutive hours at the raw wastewater and final effluent sampling locations. Grab samples were collected once daily at these two locations. A grab sample of the raw process water was also taken on the second day of the sampling survey. Table II-6 shows the work items included during a typical screening sampling program survey.

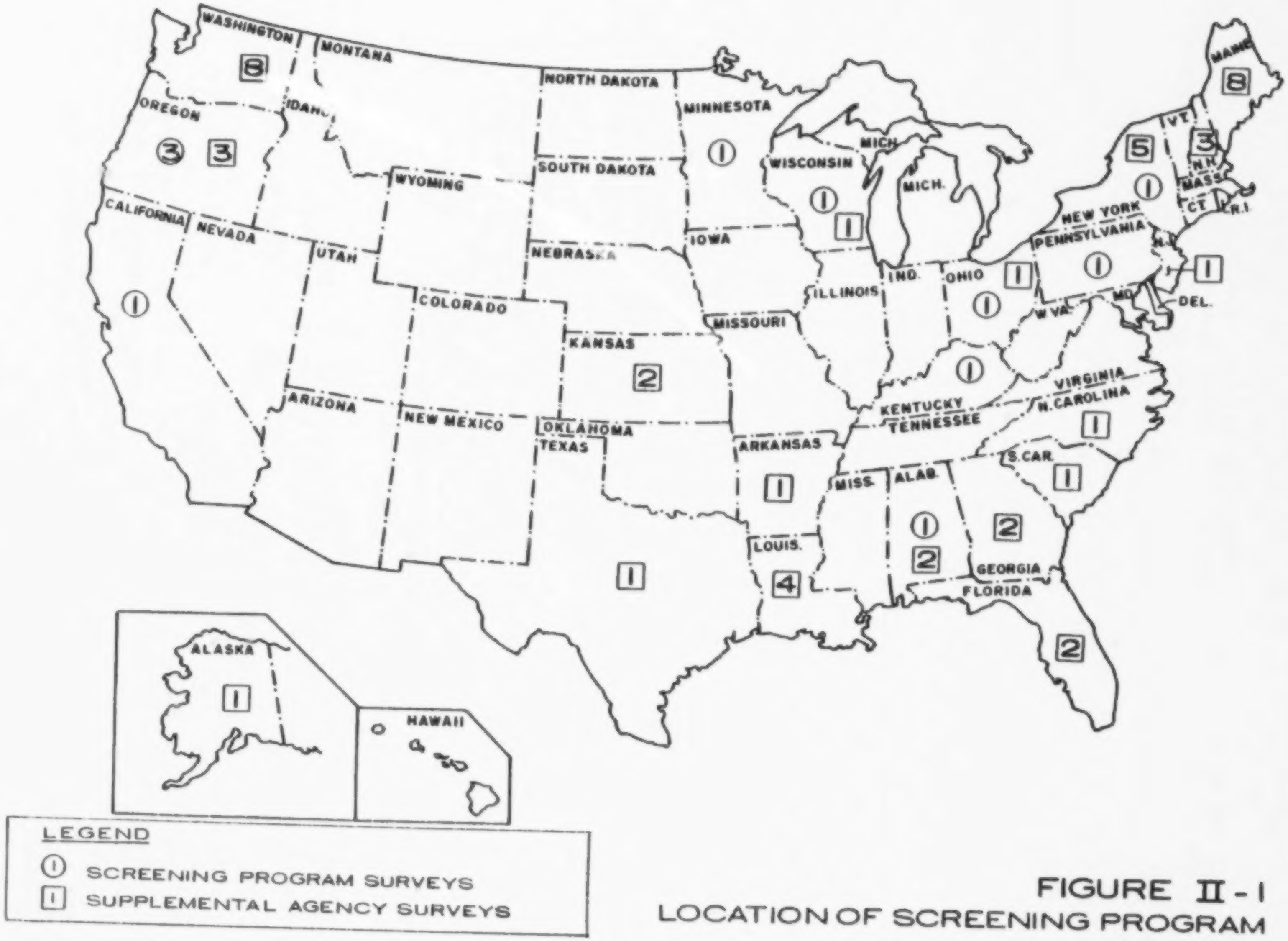

WASHINGTON
8
MONTANA
NORTH DAKOTA
MINNESOTA
1
OREGON
3
3
IDAHO
SOUTH DAKOTA
WISCONSIN
1
1
MICH.
MICH.
MAINE
8
VT.
5
3
N.H.
MASS.
CT
R.I.
1
NEW YORK
PENNSYLVANIA
1
N.J.
1
DEL.
MD
W.VA.
WYOMING
CALIFORNIA
1
NEVADA
UTAH
NEBRASKA
IOWA
ILLINOIS
IND.
OHIO
1
1
COLORADO
KANSAS
2
MISSOURI
1
KENTUCKY
TENNESSEE
VIRGINIA
N.CAROLINA
1
ARIZONA
NEW MEXICO
OKLAHOMA
TEXAS
1
ARKANSAS
1
MISS.
ALAB.
1
2
S.CAR.
1
2
GEORGIA
FLORIDA
2
LOUIS.
4
ALASKA
1
HAWAII
LEGEND
① SCREENING PROGRAM SURVEYS
[1] SUPPLEMENTAL AGENCY SURVEYS

FIGURE II - I
LOCATION OF SCREENING PROGRAM
MILL SURVEYS

TABLE II-6

TYPICAL SCREENING PROGRAM SURVEY

Day 1 of the Survey	Day 2 of the Survey	Day 3 of the Survey	Day 4 of the Survey
1. Meet with mill personnel and discuss the program	1. Check automatic samplers	1. Check automatic samplers	1. Distribute 72-hour composite between the required composite samples
2. Select sample locations	2. Collect all grab samples required	2. Collect all grab samples required	2. Break down automatic samplers
3. Set up automatic samplers	3. Take pH and temperature readings at each sample location twice during 24 hours	3. Take pH and temperature readings at each sample location twice during 24 hours	3. Final meeting with mill personnel to wrap up the survey
4. Collect all grab samples required	4. Check automatic samplers periodically and keep composite sample container iced	4. Check automatic samplers periodically and keep composite sample container iced	4. Pack the samples and equipment for shipment
5. Take pH and temperature readings at each sample location twice during 24 hours			5. Ship samples to the appropriate analytical laboratory
6. Check automatic samplers periodically and keep composite sample container iced			

To minimize biochemical degradation of the sample, the composite sampler jar was packed in ice during the 72-hr sampling period. Grab samples were collected and immediately packed in ice. All composite samples were also packed in ice immediately after the appropriate containers were filled at the end of the 72-hr period at each location.

Split Sampling Program. At each mill sampled, the screening survey team also split samples, both grab and composite, for analysis by representatives of the National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI). The bottles for the NCASI samples were prepared and delivered to each mill by NCASI personnel in Gainesville, Florida. For these split samples, mill personnel assumed responsibility for the bottles prior to and immediately after sample collection. At most of the mills sampled, a member of the mill staff was present during sample collection.

Sample Analysis Procedures. The screening program samples were analyzed in accordance with EPA procedures. The organic compounds were analyzed by gas chromatography/mass spectrometry (GC/MS). (15) Resin acids, fatty acids, and bleach plant derivatives were analyzed in accordance with Analysis Procedures for Screening of Pulp, Paper, and Paperboard Effluents for Nonconventional Pollutants (EPA, Washington, D.C., December, 1980).(16) These procedures involve derivatization of the acid extract with a methylating agent prior to analysis by GC/MS.

Metals were analyzed by the following method(s):

- beryllium, cadmium, chromium, copper, nickel, lead, silver, arsenic, antimony, selenium, and thallium were first analyzed by flameless atomic adsorption (AA). If the metal was above the dynamic range of the flameless AA, the metal was then analyzed by flame AA.
- zinc was analyzed by flame AA.
- mercury was analyzed by cold vapor flameless AA.
- cyanide was analyzed in accordance with the total cyanide method described in the 14th Edition of Standard Methods. (18)

Industry Profile and Review of Subcategorization

Earlier efforts to develop a profile of the pulp, paper, and paperboard industry resulted in establishing the original (BPT) subcategories shown in Table II-7. During the screening program, available data and newly obtained information resulting from the data request program were reviewed to develop a revised profile of the pulp, paper, and paperboard industry. This review recognized such factors as plant size, age, location, raw material usage, production process controls employed, products manufactured, and effluent treatment employed.

TABLE II-7

SUBCATEGORIZATION SCHEME ON WHICH BPT WAS BASED AND THE REVISED SUBCATEGORIZATION SCHEME

BPT Subcategories
Pulp, Paper, and Paperboard

Phase I

Unbleached Kraft
Neutral Sulfite Semi-Chemical - Ammonia
Neutral Sulfite Semi-Chemical - Sodium
Unbleached Kraft/Neutral Sulfite Semi-Chemical (Cross Recovery)
Paperboard From Wastepaper

Phase II

- Dissolving Kraft
- Market Bleached Kraft
- BCT Bleached Kraft
- Fine Bleached Kraft
- Papergrade Sulfite
  - o Blow Pit Wash (plus allowances)
- Papergrade Sulfite
  - o Drum Wash (plus allowances)
- Dissolving Sulfite Pulp
  - o Nitration
  - o Viscose
  - o Cellophane
  - o Acetate
- Groundwood - Chemi-Mechanical
- Groundwood - Thermo-Mechanical
- Groundwood - CMN Papers
- Groundwood - Fine Papers
- Soda
- Deink
- Nonintegrated-Fine Papers
- Nonintegrated-Tissue Papers
- Tissue From Wastepaper

Builders' Paper and Board Mills
Phase I

Builders' Paper and Roofing Felt

Revised Subcategories

Integrated Segment

- Dissolving Kraft
- Market Bleached Kraft
- BCT Bleached Kraft
- Fine Bleached Kraft
- Soda
- Unbleached Kraft
  - o Linerboard
  - o Bag
- Semi-Chemical
- Unbleached Kraft and Semi-Chemical
- Dissolving Sulfite Pulp
  - o Nitration
  - o Viscose
  - o Cellophane
  - o Acetate
- Papergrade Sulfite (Blow Pit Wash)
- Papergrade Sulfite (Drum Wash)
- *Groundwood - Chemi-Mechanical
- Groundwood - Thermo-Mechanical
- Groundwood - CMN Papers
- Groundwood - Fine Papers

Secondary Fibers Segment

- Deink
  - o Fine Papers
  - o Tissue Papers
  - o Newsprint
- Tissue From Wastepaper
- Paperboard From Wastepaper[1]
  - o Corrugating Medium Furnish
  - o Noncorrugating Medium Furnish
- Wastepaper-Molded Products
- Builders' Paper and Roofing Felt

Nonintegrated Segment

- Nonintegrated - Fine Papers[1]
  - o Wood Fiber Furnish
  - o Cotton Fiber Furnish
- Nonintegrated - Tissue Papers
- Nonintegrated - Lightweight Papers
  - o Lightweight
  - o Electrical
- Nonintegrated-Filter and Nonwoven Papers
- Nonintegrated-Paperboard

Mill Groupings

- **Integrated Miscellaneous, including:
  - o Alkaline-Miscellaneous
  - o Nonwood Pulping
- **Secondary Fiber Miscellaneous
- **Nonintegrated Miscellaneous

* In subsequent Tables information on Groundwood-Chemi-Mechanical mills is included with information on Integrated Miscellaneous mills.
** Groupings of miscellaneous mills - not subcategories.

[1] These subcategories were subdivided after the Verification Program in response to industry comments.

As part of this updated industry-wide survey, EPA reviewed the original subcategorizaton scheme using the more comprehensive data obtained during the screening program, the data request program, and related efforts. As a result, a new subcategorization scheme was developed and is also shown in Table II-7. This revised subcategorization better reflects the industry as it now operates with respect to raw materials, processing sequences, and product mix. EPA used the revised subcategorization scheme in designing and conducting the verification program, as discussed below. A more detailed explanation of the rationale and process of subcategorization is presented in Section IV of this document.

Verification Program

The verification program was undertaken to verify the presence of the compounds found during the screening program and to obtain information on the quantity of toxic and nonconventional pollutants present in pulp, paper, and paperboard industry wastewaters.

Selection of Significant Parameters. As discussed previously, after completion of the 11 screening sampling visits, funding for this project was depleted due to delays of supplemental appropriations from Congress. Monies allocated for completion of the technical study became available after a delay of seven months. Keeping in mind the court-imposed deadlines, the Agency determined that any further delay in initiation of the verification program was intolerable. During the period of delay, a methodology was developed that would allow initiation of the verification program immediately upon availability of funding and would also provide for development of the same high quality of data that would be obtained if the screening program had been completed.

Specific toxic pollutants to be analyzed during the verification program were selected on the basis of the best information available to the Agency. This necessitated a heavy reliance on analytical data gathered during the abbreviated screening program. All specific toxic pollutants identified as present in discharges from the 11 sampled mills would be analyzed during the verification program. In addition, EPA decided that both screening and verification studies would be conducted simultaneously at all verification mills where processes were employed that were representative of the four mill groupings not previously a part of the screening program.

It was decided that GC/MS procedures would be used during the verification program because this would allow storage of all verification data on computer tapes. This would enable a review of the data tapes upon a determination that other specific toxic pollutants were present in pulp, paper, and paperboard effluents that were not identified at the 11 screening mills. This storage of data ensured that the verification program would yield comparable results to that which would have been obtained had screening results been available from mills representative of all 15 mill groups.

EPA later determined that further analysis of the data tapes would be unnecessary after completion of a thorough review of data gathered during (a) screening studies conducted by EPA Regional field teams and (b) contractor verification sampling at those 17 mills where processes were employed that were characteristic of the four mill groupings not a part of the initial contractor screening program. All additional compounds that were identified and were not analyzed during verification sampling were present in amounts too small to be effectively reduced by technologies known to the Administrator.

The compounds included in the verification program and the basis for their inclusion are listed on Table II-8.

Selection of Mills for Verification Program. Part I of the EPA Data Request Survey Form, returned by representatives of 644 mills, was used in selecting mills for verification program surveys.(13) One of the first items addressed in selecting verification mills was industry subcategorization. A revised subcategorization scheme was developed based on initial evaluations of the information submitted in Part I of the EPA Survey Form. Candidate mills for the verification program were listed for each of the revised subcategories. EPA established the following three criteria for selection of representative mills during verification sampling:

- the mill should be a direct discharging mill to obtain the maximum amount of data (raw waste load and treated effluent data) at a minimum number of plants,
- a biological treatment system should be employed at the mill if BPT is based on biological treatment (if BPT is based on primary treatment, the system could be a primary treatment system), and
- the final effluent flow and BOD_5 should be equal to or less than the annual average levels used in the development of BPT regulations for a specific subcategory to ensure that the mill selected would be representative of the subcategory after compliance with BPT regulations.

The raw wastewater samples taken at each verification mill allowed characterization of the levels of toxic and nonconventional pollutants that would be expected to be discharged at indirect discharging mills to publicly owned treatment works (POTWs). However, for some of the subcategories, an insufficient number of direct dischargers existed that met all selection criteria and it was necessary to sample at indirect discharging mills.

All known operating mills where newsprint is produced from deinked pulp were indirect discharging; therefore, only indirect discharging mills could be selected as verification mills. An indirect discharging mill where molded products are manufactured from wastepaper was included in the verification program as an adequate number of direct dischargers could not be found that met the remaining selection criteria. A total of 93 percent of the mills in the

TABLE II-8

VERIFICATION COMPOUNDS
PULP, PAPER, AND PAPERBOARD INDUSTRY

POLLUTANTS DETECTED IN SCREENING

Priority Pollutants

benzene
chlorobenzene
1,2-dichloroethane
1,1,1-trichloroethane
1,1-dichloroethane
1,1,2,2-tetrachloroethane
trichlorophenol*
chloroform
2,4-dichlorophenol
ethylbenzene
fluoranthene
methylene chloride
dichlorobromomethane
trichlorofluoromethane
chlorodibromomethane
isophorone
naphthalene
phenol
bis(2-ethylhexyl) phthalate
di-n-butyl phthalate
di-n-octyl phthalate
diethyl phthalate
chrysene
anthracene/phenanthrene
tetrachloroethylene
toluene
trichloroethylene
chromium
zinc
nickel
copper
lead
PCB-1242 - wastepaper users only
PCB-1254 - wastepaper users only
PCB-1221 - wastepaper users only
PCB-1232 - wastepaper users only
PCB-1248 - wastepaper users only
PCB-1260 - wastepaper users only
PCB-1016 - wastepaper users only
cyanide - wastepaper users only

Nonconventional Pollutants

oleic acid
linoleic acid
linolenic acid
pimaric acid
isopimaric acid
dehydroabietic acid
abietic acid
3,4,5-trichloroguaiacol
tetrachloroguaiacol
monochlorodehydroabietic acid
dichlorodehydroabietic acid
9,10-epoxystearic acid
9,10-dichlorostearic acid
xylenes

OTHER VERIFICATION POLLUTANTS

Priority Pollutants

bromoform	detected by industry in split screening samples
pentachlorophenol	detected by industry in split screening samples
carbon tetrachloride	detected by industry in split screening samples
2-chlorophenol	usage indicated on at least one 308 questionnaire
2,4-dinitrophenol	usage indicated on at least one 308 questionnaire
butyl benzyl phthalate	usage indicated on at least one 308 questionnaire
parachlorometa cresol	added because compound is a chlorinated phenolic
acenaphthylene	not detected but added to verification list due to an inadvertent error
pyrene	originally reported in screening results; upon finalizing screening data (subsequent to development of verification program), it was determined that this compound was not present
mercury	previously used in slimicide formulations

Nonconventional Pollutants

color
ammonia

---

*Includes 2,4,5 and 2,4,6 - trichlorophenol builders' paper and roofing felt subcategory were either indirect discharging (63 percent) or self-contained (30 percent). The only direct discharging mill meeting the above criteria was sampled by an EPA Regional Surveillance and Analysis field team as part of the screening program. Therefore, three indirect discharging facilities and one self-contained mill were included in the verification program.

For some subcategories, insufficient direct discharging mills with biological treatment systems existed that met the other selection criteria. Therefore, some mills were sampled where only primary treatment systems were employed. This was the case at one of the three mills sampled in the tissue from wastepaper subcategory. In the paperboard from wastepaper subcategory, EPA sampled one mill where only primary treatment was employed because extensive wastewater recycle was practiced that enabled attainment of BPT limitations without the use of biological treatment. This is the case at a significant number of mills in this subcategory.

In most of the nonintegrated subcategories, primary treatment is the system employed at the majority of the mills. Therefore, some mills with only primary treatment were selected for sampling. One of the three mills selected in the nonintegrated-fine papers subcategory, one of the two selected in the nonintegrated-tissue papers subcategory, one of the two in the nonintegrated-filter and nonwoven papers subcategory, and all three of the nonintegrated mills that could not be placed in a specific subcategory had only primary treatment.

In some of the subcategories, after reviewing the wastewater data, EPA found that an insufficient number of mills met the third criteria. Therefore, mills were selected where final effluent levels of flow and/or BOD5 were in excess of the annual average levels upon which the BPT limitations were based.

Those mills where the above criteria were met, with the exceptions discussed above, were considered primary candidates for inclusion in the verification program. After completion of this evaluation, EPA evaluated additional specific process and wastewater selection criteria. Prior to final selection of mills to be included in the verification program, the following were also considered:

1. raw wastewater and final effluent flow and BOD5 in relation to BPT limitations,

2. average daily production rates and raw material usage,

3. the Kappa or permanganate number (if applicable to the subcategory that was analyzed),

4. the type of debarking used, wet or dry (if applicable to the subcategory analyzed),

5. the brown stock washer efficiency in terms of kilograms (pounds) of soda loss (if applicable to the subcategory analyzed),

6. bleach plant data (if applicable to the subcategory analyzed) including:

- a. bleaching sequence,
- b. tonnage,
- c. shrinkage,
- d. brightness,
- e. fresh water usage, and
- f. type of washing system employed.

7. the type of evaporator condenser used (if applicable to the subcategory analyzed),

8. the number of papermachines used (if applicable to the subcategory analyzed),

9. the number of papermachines for which saveall s were utilized for fiber recovery (if applicable to the subcategory analyzed), and

10. the effluent treatment system used at the mill.

Based on this review, 59 mills were initially selected for inclusion in the verification program. The number of mills selected was based on the total required to represent each of the revised subcategories.

Two of the 59 facilities selected for sampling were not sampled during the verification program. At one of the mills, union employees were on strike; at the other mill, the aeration basin was being dredged causing the discharge of much higher levels of solids than normally were experienced. No adequate replacement mills were available. EPA evaluated all of the verification program analysis results at the end of the sampling effort to determine if additional sampling or substitutions would be necessary and to assess the coverage obtained during the verification program. As a result of this assessment, two subcategories (dissolving kraft and dissolving sulfite pulp) were identified for additional verification sampling because no mills in these subcategories were included in the verification program. Three mills were selected and verification sampling was conducted at one dissolving kraft and two dissolving sulfite pulp mills. In total, 60 mills were sampled during the verification program.

The location of mills that were sampled as part of the verification program is shown on Figure II-2.

Sampling Program. The purpose of the verification program surveys w to verify the presence and quantity of those toxic and nonconventional pollutants detected during the screening program. The verification program surveys were conducted to provide a more thorough examination

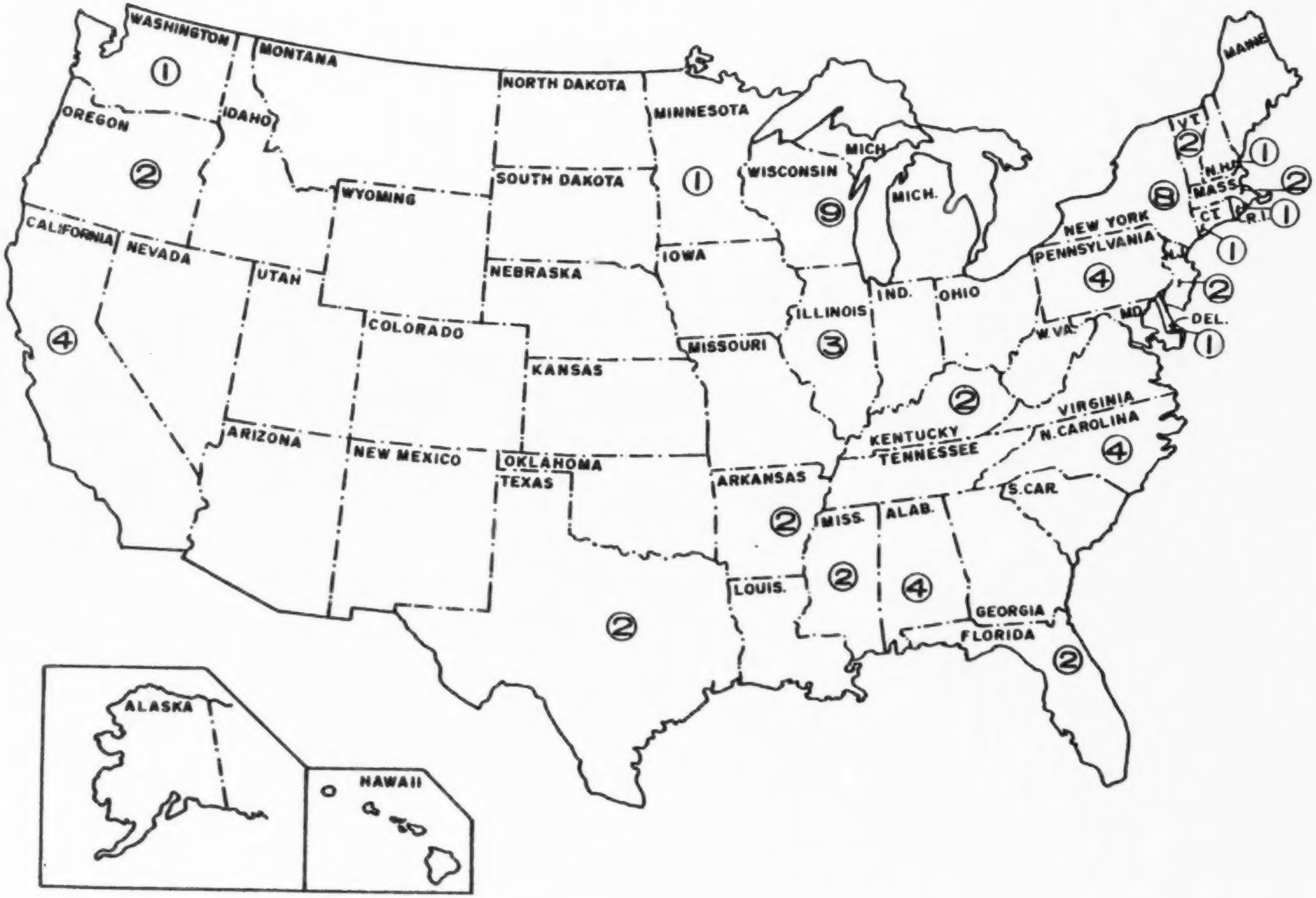

WASHINGTON ①
OREGON ②
CALIFORNIA ④
IDAHO
NEVADA
MONTANA
WYOMING
UTAH
ARIZONA
COLORADO
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS ②
MINNESOTA ①
IOWA
MISSOURI
ARKANSAS ②
LOUIS.
WISCONSIN ⑨
MICH
MICH.
ILLINOIS ③
IND.
OHIO
KENTUCKY ②
TENNESSEE
MISS. ②
ALAB. ④
GEORGIA
FLORIDA ②
S.CAR.
N. CAROLINA ④
VIRGINIA
W.VA.
MD
DEL. ①
PENNSYLVANIA ④
NEW YORK ⑧
N.J. ②
VT. ②
N.H. ①
MASS. ②
CT ①
R.I. ①
MAINE
ALASKA
HAWAII

FIGURE II-2
LOCATION OF VERIFICATION PROGRAM
MILL SURVEYS

of the possible sources of toxic and nonconventional pollutants discharged, the quantity discharged to the end-of-pipe treatment system, the levels in the final mill effluent, and the relative efficiency of the treatment system for removing specific compounds. Several different sampling procedures were examined for accomplishing these goals. Table II-9 presents the general format for sampling in particular subcategories and also presents the sample points and the sample duration proposed for each. EPA selected this format to meet the verification program goals.

EPA representatives contacted representatives of the selected mills by telephone; a confirmation letter was sent verifying the scheduled survey. This confirmation letter included submittal of two separate forms used to obtain pertinent mill operating information for the survey period and for identification of management practices (as defined in section 304(e) of the Clean Water Act of 1977) employed at the mills. (19)

A "Verification Program Work Booklet," similar to the "Screening Program Work Booklet," was developed prior to initiation of the sampling surveys.(20) The work booklet detailed the specific procedures to be followed during the survey period.

The program included collecting composite and grab samples during the 3-day survey. Composite sampling was normally performed for three separate 24-hr periods at each sample location, except for the raw process water source, where a single 72-hr composite sample was collected. In addition, certain internal sewers were monitored, usually for one 24-hr period. Compositing usually started between 8:00 and 11:00 a.m. on the first day of the survey and ended 24 hours later. Table II-10 shows the work items performed during each day of a typical verification survey.

The composite samples were divided into five aliquots including a) metals and color, b) extractable organics, c) COD, d) PCBs and pesticides (where appropriate), and e) ammonia (where appropriate). Internal sewers were not sampled for COD. Grab samples were taken once per day at each of the sample locations including the raw process water. The grab samples were taken for analysis of volatile organics, mercury, and cyanide (where appropriate). Temperature and pH readings were taken at least three times per day at each of the sample locations.

Split Sampling Program. As with the screening program, representatives of the National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI) obtained split samples. NCASI personnel shipped the necessary sampling containers to the mills. The sampling team collected the samples for NCASI and returned them to mill personnel for shipment to the appropriate NCASI laboratory for analysis. The NCASI split sampling effort did not include collection of all of the samples collected by the Agency at each mill.

TABLE II-9

VERIFICATION PROGRAM SAMPLING POINTS

Subcategory	Type of Samples and Sample Duration
Bleached Kraft/Sulfite Mills	
1. Raw Water	Grab samples (3 per day)
2. Pulp Mill/Screening	24-hr composite
3. Bleach Plant	24-hr composites
4. Secondary Treatment Influent	24-hr composites
5. Final Effluent	24-hr composites
Groundwood Mills	
1. Raw Water	Grab samples (3 per day)
2. Pulp Mill/Screening	24-hr composite
3. Secondary Treatment Influent	24-hr composites
4. Final Effluent	24-hr composites
Unbleached Kraft/Semi-Chemical Mills	
1. Raw Water	Grab samples (3 per day)
2. Pulp Mill/Screening	24-hr composite
3. Secondary Treatment Influent	24-hr composites
4. Final Effluent	24-hr composites
Secondary Fiber Mills	
1. Raw Water	Grab samples (3 per day)
2. Stock Preparation	24-hr composites
3. Secondary Treatment Influent	24-hr composites
4. Final Effluent	24-hr composites
Builders' Paper and Roofing Felt Mills	
1. Raw Water	Grab samples (3 per day)
2. Secondary Treatment Influent	24-hr composites
3. Final Effluent	24-hr composites
Paperboard From Wastepaper & Nonintegrated Mills	
1. Raw Water	Grab samples (3 per day)
2. Secondary Treatment Influent	24-hr composites
3. Final Effluent	24-hr composites

TABLE II-10

TYPICAL VERIFICATION SAMPLING PROGRAM SURVEY

Day 1 of the Survey	Day 2 of the Survey	Day 3 of the Survey	Day 4 of the Survey
1. Meet with mill personnel and discuss the program	1. Distribute 24-hour composite between the required composite samples	1. Distribute 24-hour composite between the required composite samples	1. Distribute 24-hour composite between the required composite samples
2. Select sample locations	2. Rinse sample composite container and start automatic sampler for the next 24-hr period	2. Rinse sample composite container and start automatic sampler for the next 24-hr period	2. Break down automatic sampler at each location and pack equipment
3. Discuss mill's management practices and tour mill to observe the items covered	3. Collect all grab samples required	3. Collect all grab samples required	3. Final meeting with mill personnel to wrap up the survey
4. Set up the automatic samplers	4. Take pH and temperature readings at each sample location twice during 24-hours	4. Take pH and temperature readings at each sample location twice during 24-hours	4. Pack samples in ice and ship to the appropriate laboratory
5. Collect all grab samples required	5. Check automatic samplers periodically and keep composite sample container iced	5. Check automatic samplers periodically and keep composite sample container iced	
6. Take pH and temperature readings at each sample point twice during 24-hours			
7. Check automatic samplers periodically and keep composite sample container iced			

Generally, the NCASI samples were collected as follows:(21)

Parameter	Raw Water	Influent to Treatment	Final Effluent
Extractable Organics	Day 3 of Survey	Day 1 of Survey	Day 2 of Survey
Nonconventional Pollutants	-	-	Day 1 of Survey
Metals	Day 3 of Survey	Day 2 of Survey	Day 3 of Survey
Mercury	Day 3 of Survey	-	Day 3 of Survey
Volatile Organics	Day 3 of Survey	Day 2 of Survey	Day 3 of Survey
Cyanide	Day 2 of Survey	-	Day 2 of Survey

Analytical Methods for Verification Program Analysis. The samples from each verification mill were analyzed for 18 volatile organics (VOA), 33 extractable organics, and 6 metals. Included in the extractable organics were 13 resin and fatty acids and bleach plant derivatives, nonconventional pollutants specific to the pulp, paper, and paperboard industry. In addition, samples from mills where wastepaper was used as a raw material source were analyzed for PCBs.

Copper, chromium, lead, nickel, zinc, and mercury were analyzed using the same procedures described earlier in the discussion of the screening program. Cyanide was analyzed in accordance with the total cyanide method described in the 14th Edition of Standard Methods.(18) Ammonia was analyzed by distillation and Nesslerization as described in the same edition of Standard Methods.(18) Color was analyzed in accordance with the procedures set forth in NCASI Technical Bulletin Number 253.(22) Chemical oxygen demand (COD) was analyzed in accordance with the procedures presented in the 14th Edition of Standard Methods.(18)

The procedures used to analyze samples collected during verification sampling provided for additional quality control and quality assurance over those procedures used during the screening phase. These verification procedures are the same as Methods 624 and 625 proposed under authority of sections 304(h) and 501(a) of the Act (see 40 CFR Part 136; 44 FR 69464 (December 3, 1979)). (23) The Agency chose the option of including additional quality control and quality assurance procedures described in Procedures for Analysis of Pulp, Paper, and Paperboard Effluents for Toxic and Nonconventional Pollutants (EPA, Washington, D.C., December, 1980).(24) Gas chromatography/mass spectrometry (GC/MS), interfaced with a computer system, was the primary analytical instrument for volatile and extractable organic analysis.

The computer system interfaced with the mass spectrometer allowed acquisition of continuous mass scans throughout the chromatogram. EPA representatives obtained standards for each pollutant to be assayed in the samples and determined the mass spectrum for each of these standards daily throughout the analysis program.

Duplicate 125-ml samples were collected at each sampling point for volatile organic analysis (VOA). Volatile samples were checked for chlorine content in the field and preserved with sodium thiosulfate as necessary. Volatile organic analysis utilized the purge and trap method, which is a modified gas sparging, resin adsorption technique, followed by thermal desorption and analysis by packed column GC/MS.

The sampling team collected duplicate 1-liter samples of wastewaters for analysis of extractable organic compounds. Extractable organic samples were preserved in the field with sodium hydroxide to a pH of approximately 10 or higher. For extractable organic analysis, the sample was acidified to a pH of 2 or below, extracted with methylene chloride, concentrated, and chromatographed on a GC/MS system equipped with a support-coated open tubular (SCOT) capillary column.

Extracts prepared for analysis of PCBs were analyzed by electron capture detection/gas chromatography (EC/GC). Extracts in which PCBs were detected at a level of greater than 1 ug/l were confirmed by GC/MS.

Quality Control/Quality Assurance. The verification program included the implementation of a quality control/quality assurance (QC/QA) program consisting of internal standards, field blanks, method blanks and replicate analysis. Deuterated internal standards were selected to provide QC/QA data on primary groups of pollutants under evaluation in the verification program. The deuterated compounds selected are shown in Table II-11.

These compounds were selected because of their similarity to the compounds under investigation. By adding deuterated internal standards to each sample analyzed by GC/MS, it was possible to assess system performance on a per-sample basis. Recovery of the internal standards in the volatile organic analysis assured that the apparatus was leakproof and that the analysis was valid. For extractable organic analyses, percent recoveries of the internal standards indicated the complexity of the sample matrix and the validity of the analysis. In each case, low recovery of internal standards signaled possible instrument malfunction or operator error. For analysis of volatile organic compounds, the area of the 100 percent characteristic ion for each internal standard had to agree within 25 percent with the integrated peak area obtained from analysis of the composite standard or the GC/MS sample run was repeated. Extractable organic analysis was repeated if internal standard recoveries were less than 20 percent.

To demonstrate satisfactory operation of the GC/MS system, the mass spectrometers were tuned each day with perfluorotributylamine (PFTBA) to optimize operating parameters according to the manufacturer's specifications. Calibration logs were maintained to document instrument performance. The entire GC/MS system was further evaluated with the analysis of a composite standard that contained all pollutants of interest and the various deuterated internal standards. This standard was analyzed with each sample set or with each change in

TABLE II-11

SUMMARY OF INTERNAL STANDARDS

Volatiles*

methylene chloride-d2
1,2-dichloroethane-d4
1,1,1-trichloroethane-d3
benzene-d3
toluene-d3
p-xylene-d10

Extractables

phenol-d5-TMS
naphthalene-d8
diamyl phthalate
stearic acid-d35-TMS

*Relative to benzene-d3

instrument calibration/tune. This daily analysis of the composite standard supplied data that a) verified the integrity of the chromatographic systems, b) produced acceptable low-resolution mass spectrum of each compound assayed, and c) verified machine sensitivity.

The field and method blanks were included in the analytical program to indicate possible sample contamination and confirm analytical methodologies. Field blanks were spiked with deuterated internal standards. Method blanks were spiked with the deuterated internal standards and standards for compounds under evaluation, as discussed previously. The mass spectrum for each of these standard compounds was determined daily throughout the analysis program. The blanks provided additional quality assurance, including: a) data on clean matrix recoveries and b) replicate analysis for precision determinations.

Long-Term Sampling Program

The long-term sampling program was undertaken to investigate the variability and treatability of certain toxic and nonconventional pollutants discharged from mills in the pulp, paper, and paperboard industry.

Selection of Significant Parameters. Through an evaluation of available data (primarily verification data), EPA identified certain pollutants to be of potential concern in the pulp, paper, and paperboard industry. These included chloroform, trichlorophenol, pentachlorophenol, and PCBs, which are toxic pollutants, and resin acids, fatty acids, and bleach plant derivatives, which are nonconventional pollutants. The complete list of the pollutant parameters selected for analysis during the long-term sampling program is presented in Table II-12.

Selection of Mills for the Long-Term Sampling Program. Candidate mills for the long-term sampling program were listed for each of the following five major industry sectors; bleached kraft, unbleached kraft/semi-chemical, deink with bleaching, wastepaper without bleaching, and bleached sulfite. The following criteria were established for selection of the mills:

- the mills should be located close to the northeastern quarter of the U.S. to minimize cost, and
- the final effluent flow and BOD_5 for each mill chosen should be equal to or less than the annual average levels that formed the basis of BPT regulations to ensure that the mill selected would be representative of the industry sector after compliance with BPT regulations.

Due to budgetary concerns, only two mills could be chosen. Therefore, the candidate mill list was reduced to include only mills representing industry sectors that were best suited for this program. A review of

TABLE II-12

TOXIC AND NONCONVENTIONAL POLLUTANTS SELECTED FOR ANALYSIS DURING THE LONG-TERM SAMPLING PROGRAM

Toxic Pollutants

Chlorinated Phenolics:
- 2,4-dichlorophenol
- trichlorophenol[1]
- pentachlorophenol

Halomethane:
- chloroform

Polychlorinated Biphenyls (PCBs)[2]
- PCB-1016
- PCB-1221
- PCB-1232
- PCB-1242
- PCB-1248
- PCB-1254
- PCB-1260

Nonconventional Pollutants

Chlorinated Phenolics:
- 4,5-dichloroguaiacol
- 3,4,5-trichloroguaiacol
- 4,5,6-trichloroguaiacol
- tetrachloroguaiacol

Unsaturated Fatty Acids:
- oleic acid
- linoleic acid
- linolenic acid

Unsaturated Fatty Acid Derivatives:
- 9,10-epoxystearic acid
- 9,10-dichlorostearic acid

Resin Acids:
- abietic acid
- dehydroabietic acid
- isopimaric acid
- levopimaric acid
- neoabietic acid
- palustric acid
- pimaric acid
- sandaracopimaric acid

Chlorinated Resin Acids:
- monochlorodehydroabietic acid
- dichlorodehydroabietic acid

Ethers:
- dimethyl sulfide
- dimethyl disulfide

---

[1] Includes 2,4,5 and 2,4,6-trichlorophenol.

[2] Analyzed only at deink mill.

screening and verification data showed that bleached kraft facilities could have detectable levels of all the pollutants of concern (except PCBs) in their wastewater. A further review showed that PCBs, chloroform, and the chlorophenolics could be found in wastewater discharges from deinking mills where bleaching is employed.

As a result, the candidate mill list was reduced to include only bleached kraft and deink mills. EPA selected one mill from each sector to provide full coverage of the toxic and nonconventional pollutants of concern.

Sampling Program. The purpose of the long-term sampling program was to investigate the variability and treatability of certain pollutants specific to the pulp, paper, and paperboard industry. The sampling effort was primarily designed to collect long-term data on the levels of the pollutants of interest in the final effluent of the mill's wastewater treatment plant. Raw wastewater samples were collected to determine the levels of the pollutants being discharged to the end-of-pipe treatment system and to evaluate the relative efficiency of the treatment system for removing the specific compounds.

Representatives of the selected mills were contacted by telephone and a confirmation letter was sent explaining the program. At the initial meeting with mill personnel, discussions included the need to obtain pertinent mill operating information for the duration of the sampling program.

Prior to beginning the sampling effort, EPA developed a long-term sampling work booklet for each mill sampled.(25)(26) Each work booklet detailed the specific procedures to be followed at each mill.

For the fine bleached kraft mill, sampling included collecting grab and composite samples over a 72-hour period each week for twenty-three weeks. Weekly composite sampling consisted of collecting three consecutive 24-hour composites of the final effluent and one 72-hour composite of the aeration influent. For this mill, the aeration influent was the first point at which all wastewater streams were combined.

At the deink tissue mill, sampling included collecting grab and composite samples over a 72-hour period each week for twenty-three weeks. Weekly composite sampling consisted of collecting three consecutive 24-hour composites of the final effluent, and a 72-hour composite of both the raw waste and primary clarifier effluent. The primary effluent sample point was added to the program after EPA learned that over fifty percent of the primary clarifier effluent is recycled back to the mill. By sampling the primary effluent, EPA could evaluate the treatability of the chemically assisted primary clarification system for the pollutants of interest and could estimate their levels entering secondary treatment.

At both mills, grab samples were taken three times per day at each sample point. Collection of grab samples was necessary for analysis of the volatile organic compounds of interest. Also, pH and temperature were recorded each time a grab sample was taken.

Split Sampling Program. As with the screening and verification programs, representatives of the National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI) obtained split samples. NCASI personnel shipped the necessary sampling containers to the bleached kraft mill. The sampling team collected the samples for NCASI and returned them to mill personnel for shipment to the appropriate NCASI laboratory for analysis. The NCASI split sampling effort included only six final effluent samples collected at the bleached kraft mill; none were collected at the deink mill.

Analytical Methods Used During the Long-Term Sampling Program. The analytical methods used to analyze wastewater samples from the bleached kraft mill and the deink mill are discussed below.

Bleached Kraft Mill - The wastewater samples collected at the bleached kraft mill were analyzed for all of the priority and nonconventional pollutants (except PCB's) listed in Table II-12.

The volatile organic compounds were analyzed by U.S.EPA Method 1624, "Volatile Organic Compounds by Purge and Trap Isotope Dilution GC/MS." The concentrations of dimethyl sulfide and dimethyl disulfide were determined according to Method 624 because no labeled analogs were available.

The semivolatile organic compounds were analyzed with a modified version of U.S.EPA Method 1625, "Semivolatile Organic Compounds By Isotope Dilution GC/MS." Method 1625 was modified to include SE54 fused silica wall coated open tubular gas chromatography (HRGC) and N-methyl-N-trimethylsilyl-trifluoroacetamide (MSTEA) derivatization. The modification was necessary to allow for analysis of resin and fatty acid compounds found in wood pulping discharges. The concentrations of those compounds for which no isotopic counterparts were available were determined according to Method 625.

Deink Mill. The wastewater samples collected at the deink mill were routinely analyzed for the priority pollutants only (see Table II-12).

Chloroform concentrations were determined by U.S.EPA Method 1624. The chlorophenolics were analyzed using Method 1625 as was done at the bleached kraft mill.

The PCB concentrations were determined by U.S.EPA Method 617, "Organochlorine Pesticides and PCBs." It was necessary to determine the presence of the PCBs by Method 617 since Method 625 is not sensitive enough at low levels for these compounds, the limits of detection being about 30 ppb. The PCBs were not analyzed by isotope dilution methods since labeled standards were not available. If any PCBs were detected, they were confirmed by GC/MS (though quantitated by GC/EC).

To investigate the levels of the nonconventional pollutants at the deink mill, fifteen final effluent samples were randomly selected and analyzed. Volatile and semivolatile nonconventional pollutants were analyzed by using Methods 624 and 625, respectively, as for the bleach kraft samples.

Quality Assurance/Quality Control. The long-term sampling program included the implementation of separate quality assurance/quality control (QA/QC) procedures for each mill. Analyses of chloroform and the chlorophenolics at both mills allowed similar QA/QC procedures for these compounds; however, analyses for the nonconventional pollutants at the bleached kraft mill and PCBs at the deink mill required the development of different QA/QC procedures.

For the bleached mill, the QA/QC procedures used were primarily those presented in the Federal Register (44 FR 69553, December 3, 1979) for analysis of organic priority pollutants. (23) The QA/QC program included routine QA/QC such as a preliminary, clean water precision and accuracy study, and the use of method and field blanks. The program also required that analytical methods be validated and subsequent analyses be within the validated control limits. Additional quality assurance was included for the analysis of the nonconventional pollutants for which no labeled analogs exist. Three levels of standard additions on duplicates of ten percent final effluent samples were required to provide recovery information.

Also, a mass spectrometer linearity study was conducted three times during the program. The study determined the dynamic performance range of the entire analytical system for all compounds of interest, surrogate standards, and internal standards.

For the deink mill, the use of labeled analogs for chloroform and the chlorophenolics provided recovery information for these toxic pollutants. Additional precision information was obtained by analyzing one final effluent sample in duplicate each week.

Since no labeled analogs exist for PCBs, a separate QA/QC program was developed. During the odd numbered sampling weeks (1, 3, 5, 7,...23), one final effluent sample was analyzed in duplicate to obtain precision information. During the even numbered weeks (2, 4, 6, 8,....22), one final effluent sample was analyzed first unspiked, to establish background concentration of the analyte, and then spiked, to provide recovery information.

Discharge Monitoring Data Acquisition Program

During the verification program, EPA obtained long-term conventional pollutant data from each of the mills surveyed. These data were obtained to analyze the effectiveness of in-place technology. After reviewing these data, EPA found that effluent levels attained at some mills were well below BPT limits. In addition, EPA was aware that the data request program had preceded the start-up of new treatment facilities at many mills. Based on this information, in December of

1979, EPA decided to obtain additional long-term data to evaluate the performance of treatment systems relative to BPT limitations.

This effort involved contacting personnel at EPA Regional offices and States with permitting authority to obtain discharge monitoring report (DMR) data to supplement the conventional pollutant data received during the verification program. Discharge monitoring data were obtained from five EPA Regional offices and from eleven States with permitting authority. The resulting DMR data base included 12 to 30 months of DMR data for the period between July 1977 and December 1979 for approximately 250 direct discharging mills in the industry. The data were used to develop the effluent limitations proposed for the conventional pollutants BOD_5 and TSS (see 46 FR 1430, January 6,1981).

To update and expand this data base, EPA conducted a supplemental DMR program to obtain additional data for direct, continuous discharging mills for the period between July 1977 and March 1981. All pulp, paper, and paperboard mills were identified by State, and EPA developed a list of EPA Regional offices and State agencies with permitting authority for these mills.

DMR data were received from the following EPA Regional offices and States:

EPA Region I, II, III, IV, VI, VIII, IX, and X.

Maine, New Hampshire, Connecticut, New York, Virginia, Maryland, Delaware, Tennessee, Mississippi, Alabama, Georgia, South Carolina, North Carolina, Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Kansas, Iowa, California Region I, and California Region V (Redding Office).

The number of direct discharging mills for which DMR data were collected and the number of direct discharging mills in each subcategory are presented in Table II-13.

DMR data were evaluated to identify inconsistencies. EPA also assessed the influence of treatment system startup on effluent quality. If effluent loads were found to be unusually high during startup, data were discarded to properly reflect effluent characteristics subsequent to system startup. When EPA found that long-term effluent levels were inconsistent due to production, process, or treatment system changes, the data were further scrutinized and reanalyzed or deleted from the data base. EPA developed summaries of the DMR data for inclusion in the existing data base. The DMR data are discussed and summarized in Section VIII of this document.

Supplemental Data Acquisition Program

During the BATEA review program, EPA collected 13 months of daily production and wastewater data from 54 mills to determine long-term average, maximum day, and maximum 30-day average values. EPA used

TABLE II-13

SUMMARY OF DIRECT DISCHARGING MILLS
VERSUS DMR DATA COLLECTED

Subcategory	Number of Direct[1] Discharging Mills	Number of Mills Included in Discharge Monitoring Data Base
Integrated Segment		
Dissolving Kraft	3	3
Market Bleached Kraft	12	10
BCT Bleached Kraft	9	9
Alkaline-Fine[2]	16	16
Unbleached Kraft		
o Linerboard	16	16
o Bag	11	11
Semi-Chemical	18	18
Unbleached Kraft and Semi-Chemical	9	9
Dissolving Sulfite Pulp	6	4
Papergrade Sulfite[3]	13	13
Groundwood - Thermo-Mechanical	3	3
Groundwood - CMN Papers	3	3
Groundwood - Fine Papers	7	7
Integrated Miscellaneous	75	71
Secondary Fibers Segment		
Deink		
o Fine Papers	3	3
o Tissue Papers	11	11
o Newsprint	1	1
Tissue From Wastepaper	13	13
Paperboard From Wastepaper	45	43
Wastepaper-Molded Products	4	4
Builders' Paper and Roofing Felt	5	5
Secondary Fiber Miscellaneous	7	7
Nonintegrated Segment		
Nonintegrated - Fine Papers		
o Wood Fiber Furnish	16	16
o Cotton Fiber Furnish	5	5
Nonintegrated - Tissue Papers	15	15
Nonintegrated - Lightweight Papers		
o Lighweight Papers	10	10
o Electrical Papers	4	4
Nonintegrated - Filter and Nonwoven Papers	5	5
Nonintegrated - Paperboard	7	7
Nonintegrated Miscellaneous	26	26
Total	378	370

---

[1] The total represents all direct discharging mills known to have operated for a period of time during January 1978 and March 1981 and self-contained mills which submit DMRs. The total incudes 35 mills which share 14 joint treatment systems. Each mill is listed separately on the table although only one set of data are reported for each joint treatment system. The total also includes some mills which discharge a portion of their wastewater to POTWs.

[2] Includes Fine Bleached Kraft and Soda subcategories.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

these data to establish maximum day and maximum 30-day average variability factors in developing proposed effluent limitations and standards published on January 6, 1981 (46 FR 1430).

To broaden, update, and strengthen its data base, EPA conducted a supplemental data request program. EPA selected mills for this program based on final effluent discharge levels, wastewater monitoring frequencies, and type of treatment system employed. Data request forms were developed and submitted to representatives of each selected mill. Daily operating data were gathered from 44 mills for a period of approximately three years. The data were analyzed to determine maximum day and maximum 30-day average variability factors. One mill was subsequently identified as a noncontinuous, intermittent discharger and was dropped from the study.

PCB Data Acquisition Program

EPA conducted an extensive study to evaluate the presence and levels of PCBs discharged from pulp, paper, and paperboard mills where recycled paper is used as furnish. EPA Regional offices, State agencies with permitting authority, and environmental agencies were contacted for information; those states which require PCB monitoring were identified. Raw waste and final effluent data were obtained for 49 mills from data suplied by the States of New York, Wisconsin, and Oklahoma and from an evaluation of discharge monitoring report and verification sampling data.

Data Obtained From Industry on Proposed Regulations

The industry, through its comments on the January 1981 proposed regulations, supplied additional toxic and nonconventional pollutant data. Chloroform, ammonia, trichlorophenol, and pentachlorophenol data supplied by industry representatives in their comments are summarized in Section V.

Analysis of Treatment Alternatives

As a result of a review of available literature, EPA identified numerous production process controls and effluent treatment technologies that are applicable for control of the discharge of conventional, toxic, and nonconventional pollutants. These processes and systems include those currently in use in the pulp, paper, and paperboard industry and those demonstrated at a laboratory or pilot scale and/or demonstration level within an industrial category including the pulp, paper, and paperboard industry. The production process controls and effluent treatment technologies evaluated and their area of application are presented in Table II-14. EPA evaluated this information, along with the data developed through the data request, screening, verification, and supplemental data request programs, to determine reduction/removal capabilities of applicable control and treatment technologies.

TABLE II-14

PRODUCTION PROCESS CONTROLS AND EFFLUENT TREATMENT TECHNOLOGIES

Production Process Controls

1. Woodyard/Woodroom
   a. Close-up or dry woodyard and barking operation
   b. Segregate cooling water

2. Pulp Mill
   a. Reuse blow condensates
   b. Reduce groundwood thickener overflow
   c. Spill collection

3. Washers and Screen Room
   a. Add 3rd or 4th stage washer or press
   b. Recycle more decker filtrate
   c. Reduce cleaner rejects and direct to landfill

4. Bleaching
   a. Countercurrent or jump stage washing
   b. Evaporate caustic extract filtrate

5. Evaporation and Recovery Areas
   a. Recycle condensate
   b. Replace barometric condenser
   c. Boil out tank
   d. Neutralize spent sulfite liquor
   e. Segregate cooling water
   f. Spill collection

6. Liquor Preparation Area
   a. Green liquor dregs filter
   b. Lime mud pond
   c. Spill collection
   d. Spare tank

7. Papermill
   a. Spill collection
      1. Paper machine and bleached pulp spill collection
      2. Color plant
   b. Improve saveall
   c. High pressure showers for wire felt cleaning
   d. White water use for vacuum pump seal water
   e. Paper machine white water shower wire cleaning
   f. Additional white water storage upsets and pulper dilution
   g. Recycle press effluent
   h. Reuse of vacuum pump water
   i. Broke storage
   j. Wet lap machine
   k. Separate cooling water
   l. Cleaner rejects to landfill
   m. Addition of fourth stage cleaners

TABLE II-14
(continued)

8. Steam Plant and Utility Areas
a. Segregate cooling water
b. Lagoon for boiler blowdown and backwash waters

9. Recycle of Effluent
a. Filtrate
b. Sludge

10. Substitution of Chemicals

Other Technologies
a. Oxygen bleaching process
b. Rapson/Reeve process
c. Sequential chlorination
d. Displacement bleaching

Effluent Treatment Technologies
1. Primary Clarification
2. Biological Treatment
    a. Oxidation basins
    b. Aerated stabilization basin
    c. Activated sludge
    d. Rotating biological contactor
    e. Anaerobic contact filter
    f. Ammonia removal by nitrification
3. Chemically Assisted Clarification
4. Foam Separation
5. Activated Carbon Adsorption
6. Steam Stripping
7. Reverse Osmosis/Freeze concentration
8. Filtration
9. Dissolved Air Flotation
10. Ultrafiltration
11. Polymeric Resin Adsorption
12. Amine Treatment
13. Electrochemical Treatment
14. Microstraining
15. Oxidation

EPA identified several technology options for consideration as the basis of BPT and BAT effluent limitations, NSPS, PSES, and PSNS. These options include combinations of the technologies presented on Table II-14. EPA assessed the pollutant removal capabilities of these technology options; the results of this analysis are presented in Section VIII of this document.

Analysis of Cost and Energy Data

Through the data assessment phase, mill surveys, EPA data requests, and DMR data requests, baseline data have been gathered for analysis. Data obtained and evaluated include: a) age of mill, b) production process controls employed, c) effluent treatment technology employed, d) cost for the technology employed (if available), e) site conditions (i.e., ledge, poor soils), and f) land availability. EPA used these data to characterize model facilities representative of each subcategory of the pulp, paper, and paperboard and builders' paper and board mills point source categories.

EPA developed appropriate model mill sizes for each subcategory to properly account for economies of scale. The Agency estimated the costs of implementation of various control and treatment options for these model mills.

In developing cost data for implementation of available production process controls and end-of-pipe treatment, EPA estimated the costs of construction materials in terms of first quarter 1978 dollars. Equipment and material suppliers were contacted to aid in developing these estimates. Installation, labor, and miscellaneous costs for such items as electrical, instrumentation, and contingencies have been added to determine a total construction cost, depending on the controlling parameters. Cost data are presented in Appendix A of this document.

EPA used its cost estimates to assess the economic impacts (including price increases, profitability, industrial growth, plant closures, production changes, employment effects, consolidation trends, balance of trade effects, and community and other dislocation effects) of each of the identified control and treatment options. These economic impacts are discussed in detail in a separate report: Economic Impact Analysis of Effluent Limitations and Standards for the Pulp, Paper, and Paperboard Industry (U.S. EPA, October 1982). (27)

EPA estimated baseline energy consumption and solid waste generation and the incremental increase in energy and solid waste resulting from implementation of various technology options. Information gathered through the data request program and subsequent inputs from industry representatives were used in establishing this baseline. Energy consumption data are also presented in Appendix A of this document.

SECTION III

DESCRIPTION OF THE INDUSTRY

INTRODUCTION

EPA identified a total of 674 operating facilities (as of April 12, 1982) involved in the manufacture of pulp, paper and paperboard products. The mills vary in size, age, location, raw material usage, products manufactured, production processes employed, and effluent treatment systems employed. This highly diversified industry includes the production of pulp, paper, and paperboard from wood and nonwood materials such as jute, hemp, rags, cotton linters, bagasse, and esparto. The pulp, paper, and paperboard industry includes three major segments: integrated, secondary fibers, and nonintegrated mills. Mills where pulp alone or pulp and paper or paperboard are manufactured on-site are referred to as integrated mills. Those mills where paper or paperboard are manufactured but pulp is not manufactured on-site are referred to as nonintegrated mills. Mills where wastepaper is used as the primary raw material to produce paper or paperboard are referred to as secondary fibers mills.

A wide variety of products including pulp, newsprint, printing and writing papers, unbleached and bleached packaging papers, tissue papers, glassine, greaseproof papers, vegetable parchment, special industrial papers, and bleached and unbleached paperboard are manufactured through the application of various process techniques. The industry is sensitive to changing demands for paper and paperboard products; operations are frequently expanded or modified at mills to accommodate new product demands.

RAW MATERIALS

During the nineteenth century, wood began to supplant cotton and linen rags, straw, and other less plentiful fiber sources as a raw material for the manufacture of paper products. Today, wood is the most widely used fiber source in the pulp, paper, and paperboard industry and accounts for over 98 percent of the virgin fiber sources used in papermaking.

In recent years, secondary fiber sources, such as wastepaper of various classifications, have gained increasing acceptance. In 1976, more than 22 percent of the fiber furnish in the U.S. was derived from wastepaper.

STANDARD MANUFACTURING PROCESSES

The production of pulp, paper, and paperboard involves several standard manufacturing processes including (a) raw material preparation, (b) pulping, (c) bleaching, and (d) papermaking. Each of these processes and their variations are described below.

Raw Material Preparation

Depending on the form in which the raw materials arrive at the mill, log washing, bark removal, and chipping may be employed to prepare wood for pulping. These processes can require large volumes of water, but the use of dry bark removal techniques or the recycle of wash water or water used in wet barking operations significantly reduces water consumption.

Pulping

Pulping is the operation of reducing a cellulosic raw material into a form suitable for chemical conversion or for further processing into paper or paperboard. Pulping processes vary from simple mechanical action, as in groundwood pulping, to complex chemical digesting sequences such as in the alkaline, sulfite, or semi-chemical processes.

Mechanical Pulping. Mechanical pulp is commonly known as groundwood. There are two basic processes: a) stone groundwood where pulp is made by tearing fiber from the side of short logs (called billets) using a grindstone, and b) refiner groundwood where pulp is produced by passing wood chips through a disc refiner.

In the chemi-mechanical modification of the groundwood process, wood is softened with chemicals to reduce the power required for grinding. In a relatively new process called thermo-mechanical pulping, chips are first softened with heat and then disc-refined under pressure.

Mechanical pulps are characterized by yields of over 90 percent of the original substrate. The pulp produced is relatively inexpensive and requires minimal use of forest resources because of these high yields. Because mechanical pulping processes do not remove the natural wood binders (lignin) and resins inherent in the wood, mechanical pulp deteriorates quite rapidly. The pulp is suitable for use in a wide variety of consumer products including newspapers, tissue, catalogs, one-time publications, and throw-away molded items. Natural oxidation of the impure cellulose causes an observable yellowing early in the life of such papers. Also, a physical weakening soon occurs. Thus, the use of groundwood pulp in the manufacture of higher quality grades of paper requiring permanence is not generally permissable.

Chemical Pulping. Chemical pulping involves the use of controlled conditions and cooking chemicals to yield a variety of pulps with unique properties. Chemical pulps are converted into paper products that have relatively higher quality standards or require special properties. There are three basic types of chemical pulping now in common use: a) alkaline, b) sulfite, and c) semi-chemical.

Alkaline - The first alkaline pulping process (developed in the nineteenth century) was the soda process. This was the forebearer of the kraft process. The kraft process produces a stronger pulp and is currently the dominant pulping process worldwide. At present, there is only one operating soda mill in the United States. All other mills have been converted to the kraft process.(28)

Early in the twentieth century, the kraft process became the major competitor of the sulfite process for some grades of pulp. Kraft pulp now accounts for over 80 percent of the chemical pulp produced in this country and the role of kraft continues to increase. Although sulfite is still preferred for some grades of products, sulfite production is declining.

Several major process modifications and achievements have resulted in the widespread application of the kraft process. First, because of their increasing cost, chemicals must be recovered for economic reasons. In the 1930's, successful recovery techniques were applied to this process; these techniques have vastly improved in recent years. Second, the process was found to be adaptable to nearly all wood species. Its application to the pulping of southern pines resulted in a rapid expansion of kraft pulping to that area of the country.(28) Third, new developments in bleaching of kraft pulps (primarily the use of chlorine dioxide) spurred another dramatic growth period in the late 1940's and early 1950's. Use of this bleaching agent in simplified bleach sequences of four or five stages enables production of high brightness kraft pulps that retain strength.

Sulfite - Sulfite pulps are associated with the production of many types of paper, including tissue and writing papers. In combination with other pulps, sulfite pulps have many applications. In addition, dissolving pulps (i.e., the highly purified chemical cellulose used in the manufacture of rayon, cellophane, and explosives) were produced solely by use of the sulfite process for many years.

Initially, sulfite pulping involved the use of calcium (lime slurries sulfited with sulfur dioxide) as the sulfite liquor base because of an ample and inexpensive supply of limestone (calcium carbonate). The use of calcium as a sulfite base has declined in recent years because the spent liquor from this base is difficult and expensive to recover or burn. If spent liquor is not recovered or burned, it must be discharged as effluent, significantly increasing end-of-pipe treatment costs. Attempts to use more than about 10 percent of the spent liquor in various by-products failed. Also, calcium use has declined because the availability of softwoods, which are most suitable for calcium-based pulping, is diminishing.(29)(30) As a result, at most calcium-based sulfite mills, the process has been altered to include the use of a soluble chemical base (magnesium, ammonia, or sodium). This permits the recovery or incineration of spent liquor.

In recent years, some sulfite mills have been converted to the kraft pulping process and others have been shut-down rather than incur the expense of installing recovery/incineration technology or converting sulfite processes to other pulping processes.(30)(31) Based on industry survey responses, calcium-based cooking chemicals are used at six papergrade sulfite mills. A magnesium base is used at seven facilities, an ammonia base at five mills, and a mixed base of sodium and calcium is used at one mill.

Semi-Chemical - Early applications of the semi-chemical process during the nineteenth century involved the cooking of chips with a neutral or slightly alkaline sodium sulfite solution. This process is called the neutral sulfite semi-chemical (NSSC) pulping process. In the 1920's, scientists at the U.S. Forest Products Laboratory demonstrated the advantages of NSSC pulping, and the first NSSC mill began operation in 1928 for production of corrugating medium.(28)

The NSSC process gained rapid acceptance because of its ability to utilize the vast quantities of inexpensive hardwoods previously considered unsuitable for producing quality pulp.(32) Also, the quality of stiffness which hardwood NSSC pulps impart to corrugated board and the large demand for this material have promoted a rapid expansion of the process.(28) Both sodium and ammonia base chemicals have been used in the NSSC process.

In the past, the small size of mills, the low organic content and heat value of the spent liquor, and the low cost of cooking chemicals provided little incentive for large capital investment for NSSC chemical recovery plants.(28) Somewhat lower cost fluidized bed recovery systems have been extensively used at NSSC mills. With ammonia-based pulping, only sulfur dioxide recovery (SO_2) is practiced, and recovery economics are marginal. With sodium-based pulping, a by-product saltcake is obtained which cannot be recycled to the semi-chemical process. This material can be sold for use at alkaline pulp mills; however, sales have been very limited because of the variable composition of the salt cake.

Recently, advances have been made in semi-chemical pulping process technology with respect to liquor recovery systems. Three no-sulfur semi-chemical processes have been developed: a) the Owens-Illinois process, b) the soda ash process, and c) the modified soda ash process. The present use of the patented Owens-Illinois soda ash-caustic pulping process permits ready recovery of sodium carbonate. With a balanced caustic make-up or selective recausticizing, a balanced pulping liquor is assured. The process uses a 15 to 50 percent caustic solution (as Na_2O), with the remainder of chemicals consisting of soda ash. Spent liquor is burned in a modified kraft-type furnace or fluidized bed. Traditionally, the difficulty has been in reclaiming sodium sulfite from NSSC liquors containing both sodium carbonate and sodium sulfite.

In the soda ash process, soda ash is used at 6 to 8 percent of the oven dried weight of wood charged to the digester. Spent liquor is burned in a fluidized bed, and the soda ash is recovered. Caustic make-up provides a balanced pH liquor for reuse. The modified soda ash process uses a small amount of caustic along with the soda ash (typically 7 to 8 percent NaOH as Na_2O).(33)

There are valid reasons for conversion from the standard NSSC pulping process:

1. A poor market for the saltcake (Na_2SO_4) by-product derived from fluidized bed recovery of NSSC liquors.

2. High make-up chemical costs, as saltcake cannot be reused in the NSSC process and sodium sulfite is not produced in most recovery schemes.

3. Sulfur emission problems can result from burning the waste liquors.

Extensive use of a kraft-type recovery furnace for chemical recovery from both kraft and semi-chemical pulping systems on a common site (unbleached kraft/semi-chemical cross recovery) is often practiced. Original practice was to apply all new cooking chemicals (i.e., Na_2CO_3 and/or Na_2SO_3) required for the semi-chemical pulping operation; often a solution of sodium carbonate is prepared and sulfited with SO_2. Make-up chemical requirements are adjusted, along with production rates, to balance the total liquor lost from both the kraft and semi-chemical pulping systems. The ratio of kraft to NSSC is about 4/1 depending upon the overall efficiency of chemical recovery. Less NSSC pulp can be made if the necessary make-up chemicals are added to the liquor at the recovery furnace (as Na_2SO_4) as in the conventional kraft system. The liquor recovered from the kraft recovery furnace will be comprised primarily of Na_2CO_3 and Na_2S, not Na_2SO_3 as desired for production of NSSC pulp. This leads to the historic trend of producing a balanced pulp ratio with make-up in the form of fresh chemicals added as NSSC liquor.

Recently, the trend is toward the use of kraft green liquor as part of the semi-chemical cooking liquor. This eliminates the reliance on 100 percent new chemicals for the semi-chemical operation. This requires adequate evaporator and recovery furnace capacity to process the extra green liquor required for the semi-chemical process. The latter approach can free the operation of the mill from adherence to strict production ratios.

Unfortunately, it appears that as the use of green liquor (Na_2S) increases, the resulting pulp is reduced in brightness and strength. Thus, while complete green liquor pulping has been practiced in a few cases, only partial substitution is the likely long-term practice.

Use of Secondary Fibers

Processing of some secondary fibers allows their use without intense processing. Other uses require that the reclaimed wastepapers be deinked, a more rigorous process technique, prior to use.

Non-Deink Wastepaper Applications. Some wastepaper can be used with little or no preparation, particularly if the wastepaper is purchased directly from other mills or converting operations where a similar product grade is manufactured. Such material is usually relatively free of dirt and can sometimes be directly slushed or blended with virgin pulps to provide a suitable furnish for the papermachine. The only cleaning and screening performed in such applications would occur with the combined stock in the papermachine's own stock preparation system.

At mills where low quality paper products (i.e., industrial tissue, coarse consumer tissue, molded items, builders' papers, and many types of paperboard) are made, extensive use is made of wastepaper as the raw material furnish. Such operations typically involve a dispersion process using warm recycled papermachine white water followed by coarse screening to remove gross contamination and debris that may have been received with the wastepaper. More extensive fine screening and centrifugal cleaners may then be used before the papermaking step.

Manufacture of higher quality products, such as sanitary tissue and printing papers, may involve the use of small percentages of wastepaper. These products require clean, segregated wastepaper and a more extensive preparation system, usually including a deinking system.

Deinking. Deinking of wastepaper has been commercially applied since the nineteenth century. However, large-scale operations that exist today were developed much more recently. Materials that must be removed in order to reclaim a useful pulp include ink, fillers, coatings, and other noncellulosic materials. Deinked pulp is used in the manufacture of fine papers, tissue, toweling, liner for some paperboards, molded products, and newsprint.

The use of detergents and solvents, instead of harsh alkalis, has permitted effective reuse of many previously uneconomical types of wastepaper. Similar advances, such as flotation deinking and recovery of waste sludge with centrifuges, may yield more effective deinking processes with lower waste loads.

Presently, however, the secondary fiber field is critically dependent upon balancing available wastepaper type with the demands of the product to be manufactured. Upgrading of low quality wastepapers is difficult and costly, with inherently high discharge of both BOD_5 and TSS to ensure adequate deinked pulp quality.

Bleaching of Wood Pulps

After pulping, the unbleached pulp is brown or deeply colored because of the presence of lignins and resins or because of inefficient washing of the spent cooking liquor from the pulp. In order to remove these color bodies from the pulp and to produce a light colored or white product, it is necessary to bleach the pulp.

The degree of pulp bleaching for paper manufacture is measured in terms of units of brightness and is determined optically using methods established by the Technical Association of the Pulp and Paper

Industry (TAPPI).(34) Partially bleached pulps (semi-bleached) are used in making newsprint, food containers, computer cards, and similar papers. Fully bleached pulp is used for white paper products. By bleaching to different degrees, pulp of the desired brightness can be manufactured up to a level of 92 on the brightness scale of 100. These techniques are described in detail in a TAPPI monograph.(35)

Bleaching is frequently performed in several stages in which different chemicals are applied. The symbols commonly used to describe a bleaching sequence are shown and defined in Table III-1. The table can be used to interpret bleaching "shorthand", which is used in later sections of this report. For example, a common sequence in kraft bleaching, CEDED, is interpreted as follows:

C = chlorination and washing,
E = alkaline extraction and washing,
D = chlorine dioxide addition and washing,
E = alkaline extraction and washing, and
D = chlorine dioxide addition and washing.

Almost all sulfite pulps are bleached, but usually a shorter sequence such as CEH is sufficient to obtain bright pulps because sulfite pulps generally contain lower residual lignin. This sequence involves chlorination, alkaline extraction, and hypochlorite application, each followed by washing.

Mechanical pulps (i.e., groundwood) contain essentially all of the wood substrate including lignin, volatile oils, resin acids, tannins, and other chromophoric compounds. The use of conventional bleaching agents would require massive chemical dosages to enable brightening to levels commonly attained in the production of bleached fully cooked kraft or sulfite pulps. Generally, mechanical pulps are less resistant to aging because of the resin acids still present, and are used in lower quality, short life paper products such as newsprint, telephone directory, catalogs, or disposable products. For these products, a lower brightness is acceptable. Groundwood may be used as produced, at a brightness of about 58 to the mid 60's (GE Brightness), or may be brightened slightly by the use of sodium hydrosulfite, sodium peroxide, or hydrogen peroxide. Generally, a single application in one stage is used, but two stages may be used if a higher brightness is required.

Hydrosulfite may be used with conventional equipment. Bleaching may be accomplished by direct addition (without air) to a tank or pipeline. Gains of 5 to 10 brightness points are possible; washing is not always necessary. Peroxides may be used to give similar brightness gains or can be used in series with hydrosulfite stages. However, higher consistencies and temperatures are required for cost-effective bleaching. Buffering agents, chelating agents, and dispersants are also used to improve bleaching efficiency.

Secondary fibers are often bleached to meet the requirements of specific grades. Again, the choice of bleaching sequence depends on

TABLE III-1

BLEACHING SYMBOLS

Symbol	Bleach Chemical or Step Represented by Symbol
A	Acid Treatment or Dechlorination
C	Chlorination
D	Chlorine Dioxide Addition
E	Alkaline Extraction
H	Hypochlorite Addition
HS	Hydrosulfite Addition
O	Oxygen Addition
P	Peroxide Addition
PA	Peracetic Acid Addition
W	Water Soak
( )	Simultaneous Addition of the Respective Agents
/	Successive Addition of the Respective Agents Without Washing in Between

whether the processed stock is composed of only fully bleached chemical pulps or if appreciable groundwood is also contained. For the latter, a brightness touch-up with peroxide or hydrosulfites may be required.

For deinked groundwood-free stocks, bleaching can be employed to eliminate the color of the dyes used in coloring or printing the sheet. Bleach demand is minimal compared to that in a pulp mill bleachery. Usually a single hypochlorite stage may suffice, although a CH or a CEH sequence may be used.

Papermaking

Once pulps have been prepared from wood, deinked stock, or wastepaper, further mixing, blending, and addition of non-cellulosic materials, if appropriate, are necessary to prepare a suitable "furnish" for making most paper or board products. Modern stock preparation systems have preset instrumentation to control blending, addition of additives, refining, mixing, and distribution of the furnish.

Two or more types of pulp are often blended to produce desired characteristics. Often, relatively long fiber softwood pulp is used to create a fiber network and to provide the necessary wet strength required during the forming process. Softwood pulps are used in the production of high strength, tear resistant paper products. Softwood pulps can be blended with shorter fiber hardwood pulps by mixing in large agitated tanks or in continuous stock blending systems. Hardwood kraft pulp is not as strong as softwood pulp but contributes valuable properties to the product such as smoothness, opacity, good printability, and porosity.

To develop the maximum strength possible in paper, the fibers must be "refined", or mechanically worked in close tolerance machines (refiners). The fiber structures are opened, thus presenting more bonding surfaces when the fibers are formed into sheets on the paper machine and dried.

Many other materials may be used to provide the unique properties of the many types of paper used today. If a printing paper is made, fillers such as clay, calcium carbonate, talc, or titanium dioxide can be added to improve smoothness, brightness, and opacity. Increased ink or water resistance may be derived by the addition of resin, synthetic sizing, or starch, either during forming or as a separate application to the semi-dry sheet at the size press.

The various papermaking processes have basic similarities regardless of the type of pulp used or the end-product manufactured. A layer of fiber is deposited from a dilute water suspension of pulp on a fine screen, called the "wire." The wire retains the fiber layer and permits water to drain through. (28) This layer is then removed from the wire, pressed, and dried. Two basic types of papermachines and variations thereof are commonly employed. One is the cylinder machine in which the wire is on cylinders which rotate in the dilute pulp furnish. The other is the Fourdrinier in which the dilute pulp furnish is deposited upon an endless wire belt. Generally, the Fourdrinier is associated with the manufacture of paper and the cylinder machine with heavier paperboard grades.

Either a Fourdrinier or cylinder forming machine may be used to make paperboard. The primary operating difference between the two machines is the flat sheet-forming surface of the Fourdrinier and the cylindrical-shaped mold of the cylinder machine. In the cylinder operation, a revolving wire-mesh cylinder rotates in a vat of dilute pulp picking up fibers and depositing them on a moving felt. The pressing and drying operations are similar to that of the Fourdrinier machine.

In the Fourdrinier operation, dilute pulp, about 0.5 percent consistency, flows from the headbox onto the endless wire screen where the sheet is formed and through which the water drains. A suction pick-up roll transfers the sheet from the wire to two or more presses which enhance density and smoothness and remove additional water. It leaves the "wet end" of the machine at about 35 to 40 percent consistency and goes through dryers, heated hollow iron or steel cylinders, in the "dry end." Because of its higher speed and greater versatility, the Fourdrinier is in more common use than the cylinder machine.

With either machine, coatings may be applied in the dry end or on separate coating machines. After initial drying on the paper machine, the sheet may be treated in a size press, and then further dried on the machine. Calender stacks and breaker stacks may be employed to provide a smoother finish, either after drying or while the sheet is still partially wet.

If smoothness and high density are required, calendering is employed on the machine just before the sheet is wound on a reel. Control of moisture in the sheet and of the pressure and number of nips applied dictates the degree of densification.

It is increasingly common to impart further improvements in appearance, printability, water resistance, or texture by "coating" the dry paper sheet. This may be done either on-machine or on a separate coater (i.e., off-machine). Coatings may be applied by rolls, metering rods, air knives, or blades. The coating commonly is a high density water slurry of pigments and adhesives which are blended, metered onto the fast moving sheet, and then dryed. Binders including various starches, latices, polyvinylacetate (PVA), and other synthetics are now used. Other types of coating operations may involve the use of recoverable solvents for the application of release agents, gummed surfaces, and other films.

Often with pigment type coatings, another operation is required to obtain the desired coated sheet smoothness and gloss. Large high speed devices similar to calenders are used; these "super calenders" have alternating steel and fabric-filled rolls that impart the polishing effect.

INDUSTRY PROFILE

Information obtained from the data request program is the main source of information used to develop a profile of the pulp, paper, and paperboard industry. In addition, several mills were identified for which responses to the data request survey were not received, which were not operating at the time of the survey, or which were inadvertently omitted from the program. EPA developed a profile of these mills by contacting representatives of the mills, EPA Regional or State authorities, and/or using industry directories. The industry profile includes information on the geographical distribution of mills by subcategory, the method of wastewater discharge, and the type of production techniques employed. More detailed profile information will be presented in later sections of this report.

Geographical Distribution

Table III-2 presents the geographical distribution of mills by EPA Region for: a) facilities operating as of April 12, 1982, for which responses to the data request survey were received, and b) facilities not responding to or not operating at the time of the survey. Information is presented based on the revised subcategorization scheme that is discussed in greater detail in Section IV.

Figure III-1 presents information on the total number of operating facilities by State. The totals shown are for the 610 operating mills that responded to the data request program and for the 64 operating mills that were not included in the program. A total of 22 mills of those responding to the data request program are now closed.

Method of Wastewater Discharge

Table III-3 presents information on the method of wastewater discharge employed at the operating mills in the pulp, paper, and paperboard industry. At fifty percent of the mills in the industry, wastewater is treated on-site in treatment systems operated by mill personnel. Mills where all or a portion of the wastewater generated is discharged to a POTW make up 39 percent of the industry. Mills where 100 percent of the wastewater generated is recycled or not discharged to navigable waters (self-contained) make up 8 percent of the industry. A total of 19 mills (3 percent) were not categorized as to the method of their discharge due to insufficient data.

Biological treatment systems are currently employed extensively at direct discharging pulp, paper, and paperboard mills to reduce BOD_5 and TSS loads. Aerated stabilization is the most common treatment process employed. At a relatively large number of plants in the nonintegrated and secondary fibers subcategories, only primary treatment is employed. Primary treatment can often achieve

TABLE III-2

SUMMARY OF ALL KNOWN OPERATING PULP, PAPER, AND PAPERBOARD MILLS BY EPA REGION

Subcategory	Mills Responding To Survey EPA Region											Mills Not Responding To Or Not Operating At Time Of Survey EPA Region										
	I	II	III	IV	V	VI	VII	VIII	IX	X	Total	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
Integrated Segment																						
Dissolving Kraft	-	-	-	3	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	0
Market Bleached Kraft	1	-	-	3	1	1	-	-	2	1	9	1	-	-	3	-	-	-	-	-	-	4
BCT Bleached Kraft	-	-	-	4	-	2	-	-	-	2	8	-	-	-	-	-	1	-	-	-	-	1
Alkaline-Fine[1]	3	1	5	2	5	3	-	-	1	-	20	-	-	-	-	-	-	-	-	-	-	0
Unbleached Kraft																						
o Linerboard	-	-	-	11	-	4	-	-	-	2	17	-	-	-	-	-	-	-	-	-	-	0
o Bag	-	-	-	5	2	3	-	-	-	1	11	-	-	-	-	-	-	-	-	-	-	0
Semi-Chemical	1	-	2	5	8	1	1	-	-	1	19	-	-	-	-	1	-	-	-	-	-	1
Unbleached Kraft and Semi-Chemical	-	-	1	3	-	3	-	-	-	3	10	-	-	-	-	-	1	-	-	-	-	1
Dissolving Sulfite Pulp	-	-	-	1	-	-	-	-	-	5	6	-	-	-	-	-	-	-	-	-	-	0
Papergrade Sulfite[2]	-	1	1	-	9	-	-	-	-	3	14	-	-	-	-	-	-	-	-	-	-	0
Groundwood-Thermo-Mechanical	1	-	-	-	-	-	-	-	-	1	2	-	-	1	-	-	-	-	-	-	1	2
Groundwood-CMN Papers	1	1	-	1	-	-	-	-	-	1	4	-	-	-	-	-	-	-	-	-	-	0
Groundwood-Fine Papers	1	1	-	-	6	-	-	-	-	-	8	1	-	-	-	-	-	-	-	-	-	1
Integrated Miscellaneous	17	11	5	20	9	8	-	1	3	10	84	-	1	2	2	-	-	-	-	-	-	5
Secondary Fibers Segment																						
Deink																						
o Fine Papers	1	-	-	-	4	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	0
o Newsprint	-	1	-	-	1	-	-	-	1	-	3	-	-	-	1	-	-	-	-	-	-	1
o Tissue Papers	4	1	1	-	5	-	-	-	1	-	12	1	1	-	-	-	2	-	-	-	-	4
Tissue From Wastepaper	5	4	3	2	3	-	-	-	2	-	19	-	-	-	-	-	-	-	-	-	-	0
Paperboard From Wastepaper	16	16	25	14	47	3	4	1	13	1	140	-	4	1	-	3	1	-	-	2	1	12
Wastepaper-Molded Products	2	-	-	2	4	1	-	-	2	1	12	-	-	1	1	1	-	-	-	-	-	3
Builders' Paper and Roofing Felt	2	2	3	11	12	10	4	-	4	3	51	-	2	1	-	-	4	-	-	2	-	9
Secondary Fibers Miscellaneous	4	3	-	-	5	1	-	-	3	1	17	-	1	-	2	2	-	-	-	-	-	5
Nonintegrated Segment																						
Nonintegrated-Fine Papers																						
o Wood Fiber Furnish	4	4	4	-	15	-	-	-	1	1	29	2	1	-	1	-	-	-	-	-	-	4
o Cotton Fiber Furnish	5	-	1	-	1	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	0
Nonintegrated-Tissue Papers	2	6	2	4	5	-	-	-	4	-	23	1	-	-	-	-	-	-	-	-	1	2

TABLE III-2 (cont.)

Subcategory	Mills Responding To Survey											Mills Not Responding To Or Not Operating At Time Of Survey										
	EPA Region											EPA Region										
	I	II	III	IV	V	VI	VII	VIII	IX	X	Total	I	II	III	IV	V	VI	VII	VIII	IX	X	Total
Nonintegrated-Lightweight Papers																						
o Lightweight Papers	3	4	-	1	3	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	0
o Electrical Papers	3	-	1	-	-	-	-	-	-	-	4	-	-	-	-	1	-	-	-	-	-	1
Nonintegrated-Filter and Nonwoven Papers	3	3	2	2	3	-	-	-	1	-	14	-	-	-	-	-	-	-	-	-	-	0
Nonintegrated-Paperboard	6	1	1	-	3	1	-	-	-	-	12	1	1	-	1	1	-	-	-	-	-	4
Nonintegrated Miscellaneous	16	8	1	2	9	-	-	-	-	-	36	1	2	1	-	-	-	-	-	-	-	4
TOTAL	101	68	58	96	160	41	9	2	38	37	610	8	13	7	11	9	9	0	0	4	3	64

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

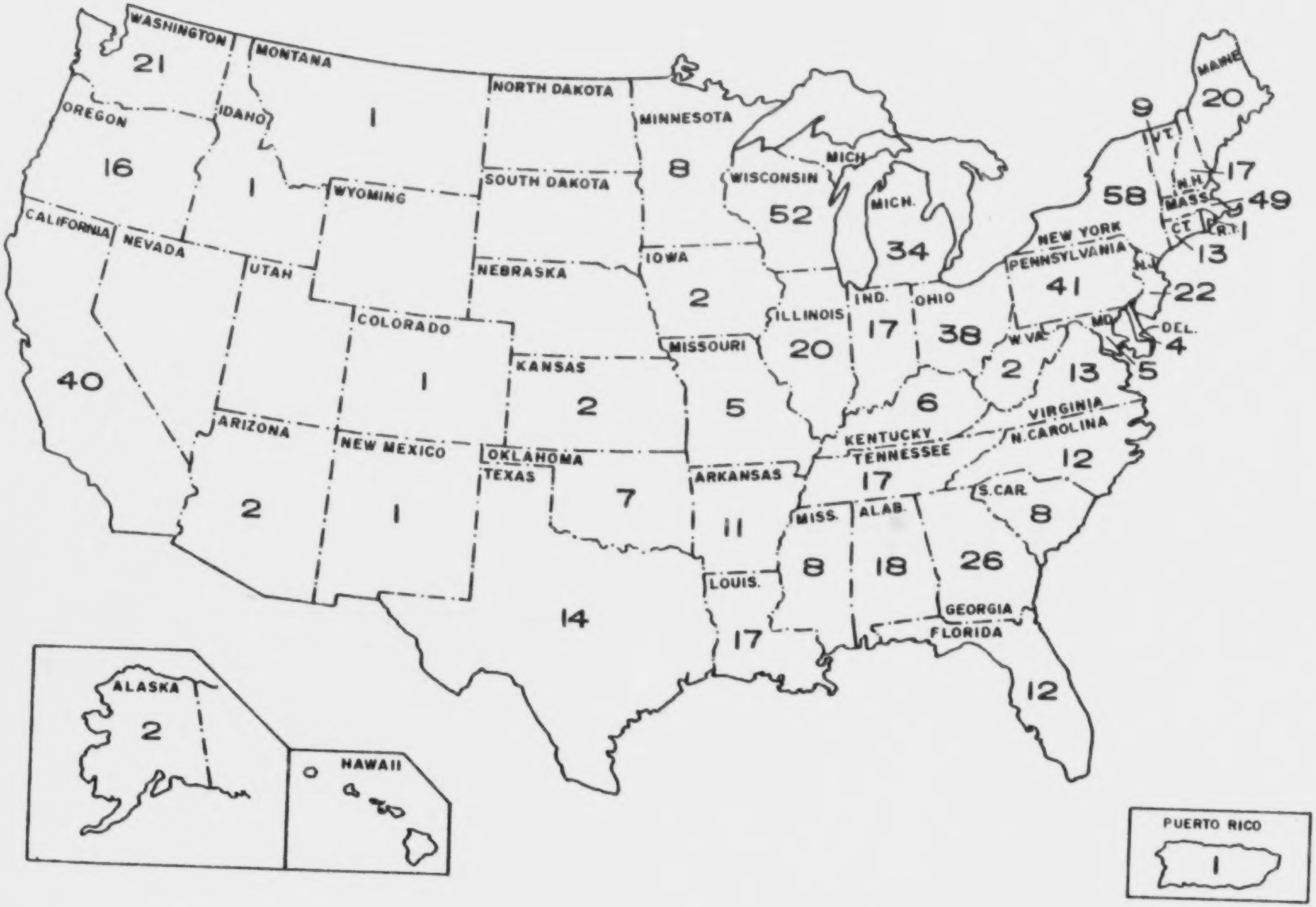

WASHINGTON
21
MONTANA
1
NORTH DAKOTA
MINNESOTA
8
OREGON
16
IDAHO
1
WYOMING
SOUTH DAKOTA
WISCONSIN
52
MICH
MICH.
34
MAINE
20
VT.
9
N.H.
17
MASS.
49
R.I.
1
CT
13
NEW YORK
58
CALIFORNIA
40
NEVADA
UTAH
NEBRASKA
IOWA
2
COLORADO
1
KANSAS
2
MISSOURI
5
ILLINOIS
20
IND.
17
OHIO
38
PENNSYLVANIA
41
N.J.
22
DEL.
4
MD
5
W.VA.
2
13
VIRGINIA
KENTUCKY
6
TENNESSEE
17
N.CAROLINA
12
S.CAR.
8
ARIZONA
2
NEW MEXICO
1
OKLAHOMA
7
TEXAS
14
ARKANSAS
11
LOUIS.
17
MISS.
8
ALAB.
18
GEORGIA
26
FLORIDA
12
ALASKA
2
HAWAII
PUERTO RICO
1

FIGURE III - I
LOCATION OF OPERATING MILLS IN THE INDUSTRY

TABLE III-3

SUMMARY OF METHOD OF DISCHARGE AND INPLACE TECHNOLOGY
All Known Operating Mills

		Method of Discharge						Treatment Scheme - Direct Discharger							
Subcategory	Number of Plants	Direct	Indirect	Indirect w/ Primary	Indirect & Direct	Self-Contained	Unknown	No External Treatment	Primary Only	ASB	ASB w/ Polishing Pond	ASB/w Holding Lagoon	Activated Sludge	Oxidation Pond	Other
Integrated Segment															
Dissolving Kraft	3	3	-	-	-	-	-	-	-	1	1	-	1	-	-
Market Bleached Kraft	13	12	-	-	-	-	1	2	-	1	3	2	3	-	1
BCT Bleached Kraft	9	9	-	-	-	-	-	-	-	3	4	1	-	-	1
Alkaline-Fine[1]	20	16	3	1	-	-	-	-	-	2	4	-	5	1	4
Unbleached Kraft															
o Linerboard	17	16	1	-	-	-	-	-	1	3	3	1	1	4	3
o Bag	11	11	-	-	-	-	-	-	-	3	3	2	2	-	1
Semi-Chemical	20	18	-	2	-	-	-	1	-	1	8	-	3	-	5
Unbleached Kraft and Semi-Chemical	11	9	1	-	-	-	1	-	-	-	5	2	1	-	1
Dissolving Sulfite Pulp	6	6	-	-	-	-	-	-	-	1	-	-	2	-	3
Papergrade Sulfite[2]	14	11	-	-	3	-	-	-	-	2	-	-	3	-	6
Groundwood-Thermo-Mechanical	4	3	-	-	-	-	1	-	-	1	-	-	1	-	1
Groundwood-CMN Papers	4	2	2	-	-	-	-	-	-	-	-	-	1	-	1
Groundwood-Fine Papers	9	7	2	-	-	-	-	-	-	-	-	-	6	-	1
Integrated Miscellaneous	89	62	15	1	7	3	1	-	4	14	14	3	19	1	7
Secondary Fibers Segment															
Deink															
o Fine	5	3	1	1	-	-	-	-	-	-	1	-	2	-	-
o Newsprint	4	1	3	-	-	-	-	-	-	-	-	-	-	-	1
o Tissue	16	11	3	-	1	1	-	-	3	1	-	-	6	-	1
Tissue From Wastepaper	19	10	2	1	-	6	-	2	2	-	3	1	-	-	2
Paperboard From Wastepaper	152	40	72	16	-	19	5	1	1	8	13	-	7	-	10
Wastepaper-Molded Products	15	4	8	-	-	1	2	2	1	1	-	-	-	-	-
Builders' Paper and Roofing Felt	60	4	29	5	-	18	4	-	1	-	2	-	-	-	1
Secondary Fibers Miscellaneous	22	7	9	3	1	-	2	1	2	1	-	-	2	-	1
Nonintegrated Segment															
Nonintegrated-Fine Papers															
o Wood Fiber Furnish	33	13	9	4	2	3	2	-	6	3	1	-	1	-	2
o Cotton Fiber Furnish	7	2	3	-	2	-	-	-	1	1	-	-	-	-	-

TABLE III-3 (cont.)

Subcategory	Number of Plants	Method of Discharge						Treatment Scheme - Direct Discharger							
		Direct	Indirect	Indirect w/ Primary	Indirect & Direct	Self-Contained	Unknown	No External Treatment	Primary Only	ASB	ASB w/ Polishing Pond	ASB/w Holding Lagoon	Activated Sludge	Oxidation Pond	Other
Nonintegrated-Tissue Papers	25	12	11	2	-	-	-	1	9	1	-	-	-	1	-
Nonintegrated-Lightweight Papers															
o Lightweight Papers	11	9	-	-	2	-	-	1	3	-	-	-	-	1	4
o Electrical Papers	5	3	2	-	-	-	-	-	-	1	-	-	-	-	2
Nonintegrated-Filter and Nonwoven Papers	14	5	7	2	-	-	-	-	1	-	1	-	1	-	2
Nonintegrated-Paperboard	16	6	10	-	-	-	-	1	3	-	2	-	-	-	-
Nonintegrated Miscellaneous	40	23	9	3	-	5	-	2	13	1	4	-	1	1	1
TOTAL	674	338	202	41	18	56	19	14	51	50	72	12	68	9	62

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

substantial BOD_5 reductions if a large percentage of the BOD_5 is contained in settleable solids.

Production Profile

Pulp. Many types of pulp are manufactured. Some types, because of fiber length and strength, are more suitable for production of certain paper grades than others. The desired pulp can be produced by varying the type(s) of raw material used, selecting an appropriate pulping process, varying the type of cooking chemicals used, and varying the time of cook. Through the use of improved processing techniques, most paper and board are comprised of more than one type of pulp to achieve desired properties.

Total daily pulp production is listed in Table III-4 by pulp type.(36)(37)

Paper and Paperboard Products. The pulp, paper, and paperboard industry manufactures a diversity of products. The various grades or types of products are delineated according to end use and/or furnish. The basic differences in the various papers include durability, basis weight, thickness, flexibility, brightness, opacity, smoothness, printability, strength, and color. These characteristics are a function of raw material selection, pulping methods, and papermaking techniques.

In addition to variations in stock preparation and sheet control on the papermachine, the papermaking operation may enhance the basic qualities of paper or may contribute other properties (i.e., wet strength, greaseproofness, printing excellence) through the use of additives. These additives include a variety of substances such as starch, clay, and resins used as fillers, sizing, and coatings.

Table III-5 presents a general list of the various products manufactured by the industry.(38) The grades listed are, for the most part, self-explanatory. Definitions according to industry usage may be found in the publication, Paper and Pulp Mill Catalog and Engineering Handbook, Paper Industry Management Association (PIMA), 1978.(37) In Table III-6, production statistics are presented for products grouped under the following major classifications: newsprint, tissue, fine papers, coarse papers-packaging and industrial converting, paperboard, and construction products.

Newsprint includes paper made largely from groundwood pulp used chiefly in the printing of newspapers.

Tissue is set apart from other paper grades and includes many different types of tissue and thin papers. These range from typical sanitary tissue products to industrial tissue which includes packing, wadding, and wrapping papers. Also many special purpose grades with unique process and product requirements such as glassine, greaseproof, electrical, and cigarette papers are produced.

TABLE III-4

ESTIMATED PULP PRODUCTION - 1977[1]

Pulp Type	Production (short tons x 1,000)
Dissolving and Special Alpha	1,465
Sulfite-Bleached	1,653
-Unbleached	389
Alkaline-Bleached	14,929
-Semi-Bleached	1,523
-Unbleached	18,411
Groundwood	4,481[2]
Semi-Chemical	3,876
Other Mechanical	2,941[2]
Screenings	110[2]
Total	49,777
Market Pulp	4,881
Waste Paper Used	14,015

---

[1] Sources used were Lockwood's Directory of the Paper and Allied Trades, Vance Publishing (1978), and Paper and Pulp Mill Catalog and Engineering Handbook, Paper Industry Management Association (1978).(36)(37)

[2] Includes insulation and hard-pressed wood fiberboard not evaluated within the scope of this study.

TABLE III-5

PAPER AND PAPERBOARD PRODUCTS OF INDUSTRY[1]

A. Paper

- I. Printing, Writing and Related
  - a. Newsprint
  - b. Groundwood paper, uncoated
    - 1. Publication and printing
    - 2. Miscellaneous groundwood
  - c. Coated printing and converting
    - 1. Coated, one side
    - 2. Coated, two sides
  - d. Book paper, uncoated
    - 1. Publication and printing
    - 2. Body stock for coating
    - 3. Other converting and miscellaneous book
  - e. Bleached bristols, excluding cotton fiber, index, and bogus
    - 1. Tab, index tag and file folder
    - 2. Other uncoated bristols
    - 3. Coated bristols
  - f. Writing and related papers not elsewhere classified
    - 1. Writing, cotton fiber
    - 2. Writing, chemical woodpulp
    - 3. Cover and text
    - 4. Thin paper
- II. Packaging and Industrial Converting
  - a. Unbleached kraft packaging and industrial converting
    - 1. Wrapping
    - 2. Shipping sack
    - 3. Bag and sack, other than shipping sack
    - 4. Other converting
      - Glassine, greaseproof and vegetable parchment
  - b. Special industrial paper
- III. Tissue and Other Machine Creped
  - a. Sanitary paper
    - 1. Toilet tissue
    - 2. Facial tissue
    - 3. Napkin
    - 4. Toweling, excluding wiper stock
    - 5. Other sanitary stock
  - b. Tissue, excluding sanitary and thin

B. Paperboard

- I. Solid Woodpulp Furnish
  - a. Unbleached kraft packaging and industrial converting
    - 1. Unbleached linerboard
    - 2. Corrugating medium
    - 3. Folding carton type
    - 4. Tube, can, and drum
    - 5. Other unbleached packaging and industrial converting kraft
  - b. Bleached packaging and industrial converting (85% or more bleached fiber)
    - 1. Folding carton type
    - 2. Milk carton
    - 3. Heavyweight cup stock
    - 4. Plate, dish, and tray
    - 5. Linerboard
    - 6. Tube, can, and drum
    - 7. Other, including solid groundwod pulp board
  - c. Semi-chemical paperboard
- II. Combination Furnish
  - a. Combination-shipping container board
    - 1. Linerboard
    - 2. Corrugating medium
    - 3. Container chip and filler
      - Combination-bending
      - Combination-nonbending
      - Gypsum linerboard
      - Special packaging and industrial converting
- III. Construction Products
  - a. Wet machine board
  - b. Construction paper and board
    - Construction paper

---

[1] Post's Pulp and Paper Directory, Miller Freeman Publications, San Francisco, California, 1979 Edition.(38)

TABLE III-6

PRODUCTION STATISTICS
PAPER AND PAPERBOARD PRODUCTS INDUSTRY[1]

Product	Production (short tons x 1000)
Paper	
Newsprint	3,515
Tissue	4,097
Fine	13,929
Coarse - Packaging and Industrial Converting	5,740
Paperboard	27,881
Construction Products	5,567

---

[1] Source was Lockwood's Directory of the Paper and Allied Trades, Vance Publishing (1978).(36)

Fine papers include printing, reproductive, and writing papers.

Packaging and industrial converting coarse papers include kraft packaging papers used for grocery and shopping bags, sacks and special industrial papers.

Paperboard includes a wide range of types and weights of products made on both cylinder and Fourdrinier machines for packaging and special purposes. Paperboard is made from various pulps, wastepaper, or combination furnishes. Board products include such items as shoe board, automotive board, and luggage board, as well as common liner, corrugating, box board, chip and filler, and gypsum board.

Construction products include various paper and board products. Paper products include sheathing paper, roofing felts (including roll roofing paper and shingles), and asbestos filled papers.

SECTION IV

SUBCATEGORIZATION

INTRODUCTION

The purpose of subcategorization is to group together mills of similar characteristics so that effluent limitations and standards representative of each group can be developed. This subcategorization scheme enables permits to be written on a uniform basis. In the original (Phases I and II) rulemaking, EPA recognized two major industry segments: integrated and nonintegrated. In recent efforts, EPA has also recognized the secondary fibers segment to better characterize the pulp, paper, and paperboard industry. The original subcategorization scheme established by the Agency follows:

Integrated

Unbleached Kraft
NSSC - Ammonia
NSSC - Sodium
Unbleached Kraft - NSSC
    (Cross Recovery)
Dissolving Kraft
Market Bleached Kraft
BCT Bleached Kraft
Fine Bleached Kraft
Soda
Papergrade Sulfite (Blow Pit)
Papergrade Sulfite (Drum Wash)
Dissolving Sulfite Pulp
Groundwood - Coarse, Molded, News (CMN) Papers
Groundwood - Fine Papers
Groundwood - Thermo-Mechanical
Groundwood - Chemi-Mechanical

Secondary Fibers

Deink
Paperboard from Wastepaper
Builders' Paper and Roofing Felt
Tissue from Wastepaper

Nonintegrated

Nonintegrated-Fine Papers
Nonintegrated-Tissue Papers

The factors considered in identifying these subcategories included raw materials used, products manufactured, production processes employed, mill size, mill age, and treatment costs.

As part of the BAT review program, the Agency collected data for operating mills in the pulp, paper, and paperboard industry. EPA reviewed the original subcategorization scheme to determine if the subcategories adequately represent current industry characteristics. This review led to the identification of four new subcategories representative of portions not recognized in the original pulp, paper, and paperboard subcategorization scheme. EPA also made other revisions to several subcategories of this industry.

Conventional pollutant data were reviewed to determine the relationship of raw wastewater characteristics to the processes employed and the products manufactured at mills in the pulp, paper, and paperboard industry. In addition, EPA gathered toxic pollutant data to evaluate the validity of the subcategorization scheme in accounting for toxic pollutant generation.

The results of these analyses are described below for each industry segment.

INTEGRATED SEGMENT

The original subcategorization scheme included 16 subcategories within the integrated segment. EPA reviewed the raw waste characteristics of mills in this segment to determine if these mills still conform to the original subcategory definitions or if differences exist because of process or product variations. Based on this review, the Agency has concluded that the original subcategorization scheme is generally representative of the integrated segment.

Conventional pollutant and flow data support segmentation to account for the different pulping processes: alkaline (kraft and soda), sulfite, semi-chemical, and groundwood (refiner or stone, thermo-mechanical, and chemi-mechanical). In addition, the production of dissolving pulps, both alkaline and sulfite, results in the generation of relatively large quantities of wastewater and wastewater pollutants and should continue to be recognized in the subcategorization scheme. Mills where pulp is bleached are characterized by higher waste loadings and must continue to be recognized separately.

In the original efforts, there were two subcategories for mills where the neutral sulfite semi-chemical pulping process (sodium and ammonia-based) is used. However, the original subcategorization scheme did not account for the full range of semi-chemical pulping operations that now exist (see Section III). The neutral sulfite process is only one type of semi-chemical process, and its use is decreasing. Available data do not support the development of separate subcategories for the new semi-chemical processes. In fact, the Agency has determined that a single semi-chemical subcategory best represents all variations of this pulping process. This single subcategory includes mills in the original ammonia-based NSSC and sodium-based NSSC subcategories and also mills where other variations of the semi-chemical process are used.

Similarly, EPA determined that a new subcategory, the unbleached kraft and semi-chemical subcategory, should be established to include all mills within the original unbleached kraft-neutral sulfite semi-chemical (cross recovery) subcategory and those mills where both the unbleached kraft and another type of semi-chemical pulping process (i.e., green liquor) are used on-site. Available data indicate that there are no significant differences in wastewater or conventional pollutant generation at mills where the neutral sulfite semi-chemical pulping process or any other semi-chemical process are used.

The original subcategorization scheme included the unbleached kraft subcategory which covered all mills where unbleached linerboard, bag, and other unbleached products are produced using the kraft pulping process. EPA reviewed available data and determined that mills where bag and other mixed products are manufactured have higher water use and BOD_5 raw waste loadings than mills where only linerboard is produced. Therefore, two product sectors were established within the unbleached kraft subcategory to account for these differences. The product sectors are (a) linerboard and (b) bag and other products.

Based on current data, there is only one mill where the soda pulping process is used. At this mill, fine bleached papers are produced. In the soda process, which is similar to the kraft pulping process, a highly alkaline sodium hydroxide cooking liquor is used as compared to the sodium hydroxide and sodium sulfide cooking liquor used in the kraft process. The raw waste loadings and flow characteristics of the soda mill are similar to those of mills in the fine bleached kraft subcategory. Accordingly, BAT effluent limitations, NSPS, PSES, and PSNS are identical for both the soda and fine bleached kraft subcategories. However, because of the familiarity of permitting authorities and representatives of affected mills with the original subcategorization scheme and the format of the Code of Federal Regulations, EPA decided that the fine bleached kraft subcategory and the soda subcategory should remain as separate subcategories and that the BPT effluent limitations promulgated for these subcategories in 1977 should not be revised. [For purposes of data presentation and development of BAT effluent limitations, NSPS, PSES, and PSNS, the soda mill has been grouped with the fine bleached kraft mills to form a new mill grouping called "alkaline-fine."]

In comments on the January 1981 proposed regulation (46 FR 1430, January 6, 1981), industry representatives suggested that the BCT bleached kraft and fine bleached kraft subcategories should be redefined based on the ash or filler content of the final product. They provided no data to support their argument but proposed that fine bleached kraft mills where less than 12 percent filler are used should be redefined as BCT bleached kraft mills and that all mills with greater than 12 percent filler should continue to be called fine bleached kraft mills. In addition, the commenters proposed that the redefined fine bleached kraft subcategory should have less stringent limitations than those of the BCT bleached kraft subcategory.

Based on industry's comments, EPA evaluated all available data on fine bleached kraft mills with less than 12 percent filler. Regression analyses indicate that there is no statistically significant relationship between percent filler and raw waste generation.

In fact, as shown below, raw waste loads at fine paper mills with less than 12 percent filler more closely resemble fine rather than BCT bleached kraft mill characteristics.

Mill Grouping	Average Raw Waste Load Flow	 BOD5	 TSS
BCT Bleached Kraft Subcategory	147.4 kl/kkg (35.4 kgal/ton)	38.4 kg/kkg (76.7 lb/ton)	66.5 kg/kkg (133.0 lb/ton)
Fine Bleached Kraft Subcategory	128.7 kl/kkg (30.9 kgal/ton)	38.6 kg/kkg (67.2 lb/ton)	75.0 kg/kkg (150.0 lb/ton)
Fine Bleached Kraft Mills with Less Than 12 Percent Filler	109.9 kl/kkg (26.4 kgal/ton)	31.3 kg/kkg (62.5 lb/ton)	35.3 kg/kkg (70.5 lb/ton)

Based on these data, EPA made no changes to the original subcategorization scheme or changes in subcategory definitions.

At the time of the data request program, there were three mills where the groundwood-chemi-mechanical pulping process was used. Because of the limited number of mills where this process is employed and inherent differences in chemicals used at these mills to produce a variety of final products, insufficient data are available to develop effluent limitations guidelines. At this time, EPA is unable to determine the effects of chemical usage in the pulping process on raw waste generation. The groundwood-chemi-mechanical subcategory remains as defined in the previous rulemaking; however, national regulations are reserved. Permits for mills in this subcategory will be determined on a case-by-case basis. It should be noted that all toxic pollutants detected in discharges from mills in this subcategory were present in amounts too small to be effectively reduced by available technologies.

In the previous rulemaking efforts, three subcategories were established to characterize the sulfite pulping process: dissolving sulfite pulp, papergrade sulfite (blow pit wash), and papergrade sulfite (drum wash). Because process differences exist between the manufacture of dissolving sulfite pulp and the manufacture of papergrade sulfite pulp resulting in significantly different raw waste characteristics, the dissolving sulfite pulp subcategory will continue to be recognized as a separate subcategory with allowances for the different types of pulps manufactured (nitration, viscose, cellulose, and acetate).

EPA's review of available data indicate that no significant differences exist between mills in the two original papergrade sulfite subcategories due to the types of washing process employed or condenser used. The Agency has determined that a single factor, the percentage of sulfite pulp produced on-site, is a better indicator of differences in raw waste loadings at papergrade sulfite mills than the type of washing system or condensers employed. Therefore, BAT effluent limitations, NSPS, PSES, and PSNS are identical for the papergrade sulfite (blow pit wash) and papergrade sulfite (drum wash) subcategories. However, because of the familiarity of permitting authorities and representatives of affected mills with the original subcategorization scheme and the format of the Code of Federal Regulations, EPA decided that the papergrade sulfite (blow pit wash) and papergrade sulfite (drum wash) subcategories should remain as separate subcategories and that the BPT effluent limitations promulgated for these subcategories in 1977 should not be revised. [In this rulemaking effort, data for mills in both papergrade sulfite subcategories have been combined in the development of effluent limitations and standards.]

In comments received on the proposed regulation, industry representatives recommended that a distinction should be made between fine and tissue production at papergrade sulfite mills. EPA examined raw waste load data for both papergrade sulfite subcategories to determine if significant differences exist due to the production of fine and tissue papers. The Agency determined that no significant differences in raw waste load flow, BOD_5, or TSS exist between fine and tissue mills. Thus, there is no justification for a separate tissue and fine paper delineation. EPA found that the percentage of sulfite pulp produced on-site is a much more significant factor affecting raw waste load than the type of product manufactured. Promulgated regulations recognize this factor through the use of a flow model that accounts for the effect of varying degrees of sulfite pulping on raw waste generation (see Section V).

SECONDARY FIBERS SEGMENT

As noted previously, EPA has identified secondary fiber mills as a separate segment of the pulp, paper, and paperboard industry. In the original rulemaking effort, four subcategories were recognized that can be considered to be a part of the secondary fibers segment: the deink, paperboard from wastepaper, tissue from wastepaper, and builders' paper and roofing felt subcategories.

Mills where molded products are manufactured from wastepaper were not addressed in the original subcategorization scheme. Where molded products are produced, the wastepaper furnish is processed without deinking. Products include molded pulp items such as fruit and vegetable packs, throw-away containers, and display items. Because waste characteristics for molded products mills are not properly represented by any of the original secondary fibers subcategories, a new subcategory, the wastepaper-molded products subcategory, has been established to include these mills.

Mills where paper is produced from wastepaper after deinking were included in the original subcategorization scheme in the deink subcategory. The principal products at these mills include printing, writing, and business papers, tissue papers, and newsprint. EPA reviewed data for this subcategory to study the relationship between the type of product manufactured and raw waste loadings. As discussed in Section V, distinct differences exist for mills where tissue papers, fine papers, or newsprint are produced. As shown in Figures V-26 and V-27, no definitive relationship exists between the percentage of deink pulp produced on-site and the associated raw waste characteristics. Therefore, the Agency determined that the deink subcategory should remain as previously defined but that regulations should reflect differences in the production of tissue papers, fine papers, and newsprint.

During the comment period following proposal, industry representatives suggested that the paperboard from wastepaper subcategory should be modified to account for differences in raw waste loads resulting from the processing of recycled corrugating medium compared to the processing of other types of recycled wastepaper. Industry commenters stated that paperboard from wastepaper mills where recycled corrugating medium is processed have experienced higher BOD5 raw waste loads today than in 1976 (the year generally represented by data presented in Section V). In 1976, the average BOD5 raw waste load for mills where a 100 percent corrugating medium furnish is processed was 11.2 kg/kkg (22.4 lb/ton). However, representatives of two mills where a 100 percent corrugating medium furnish is processed submitted data which reveal that the average BOD5 raw waste load has increased from about 10 kg/kkg (20 lb/ton) in 1976 to the present level of 23 kg/kkg (46 lb/ton). Additional supportive data were provided on the quantity of extractable BOD5 now present in waste corrugating medium. EPA has recognized this increase in BOD5 raw waste load by establishing two subdivisions of the paperboard from wastepaper subcategory: (a) the corrugating medium furnish subdivision and (b) the noncurrugating medium furnish subdivision.

In addition, industry commenters stated that mills where linerboard products are produced from wastepaper experience higher raw waste loads than other paperboard from wastepaper mills because of linerboard product requirements. EPA compared average raw waste characteristics of all mills in the paperboard from wastepaper subcategory to raw waste characteristics of mills manufacturing varying percentages of: (a) linerboard products, (b) linerboard and corrugating products, and (c) linerboard, corrugating, and folding boxboard products. No significant correlations were apparent. EPA also performed specific statistical analyses to determine if significant relationships exist between BOD5 raw waste loads and the following independent variables: (a) type of raw materials used as furnish, (b) product type, (c) pulper yield, and (d) mill size (as total production). Again, no significant correlations were apparent. In the paperboard from wastepaper subcategory, linerboard is commonly produced from recycled corrugating medium. It is likely that these commenters have experienced the same increases in BOD5 raw waste loads due to the processing of recycled corrugating medium as discussed previously. Therefore, establishment of the corrugating medium furnish subdivision accounts for this BOD5 increase and no further segmentation of the subcategory is warranted.

NONINTEGRATED SEGMENT

In the original rulemaking effort, EPA established two subcategories in the nonintegrated segment of the pulp, paper, and paperboard industry: nonintegrated-fine papers and nonintegrated-tissue papers. At nonintegrated mills where other types of products are produced, BPT permits were written on a case-by-case basis. In this study, EPA reviewed data on process and product differences in an effort to further subcategorize this industry segment. Other major types of products manufactured at mills in this segment include lightweight and thin papers, filter and nonwoven papers, paperboard, and specialty items. Because the basic manufacturing process is similar at all nonintegrated mills, EPA investigated the effects of product type on raw waste characteristics.

Based on a review of the raw wastewater characteristics of nonintegrated mills, EPA established three additional subcategories to account for the manufacture of various products: the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories. Additionally, within the nonintegrated-lightweight papers subcategory, electrical grade products are manufactured at several mills; at these mills, larger quantities of wastewater are discharged than at mills where electrical grades are not produced. Therefore, effluent limitations and standards account for this higher wastewater discharge.

In comments on the January 1981 proposed regulations, industry commenters suggested that the nonintegrated-fine papers subcategory should be further segmented to account for the higher raw waste loadings typical of mills where cotton fibers make up part of the raw material furnish. They claimed that small mills where less than 91 kkg (100 tons) per day of product are manufactured also have higher raw waste loads than do larger mills. Other commenters complained that the proposal was unclear as to whether nonintegrated mills where fine papers are produced from both wood pulp and cotton fibers were included in the nonintegrated-fine papers subcategory. Some requested that EPA establish limitations for these cotton fiber mills on a case-by-case basis and exclude them from the nonintegrated-fine papers subcategory.

In response to these comments, the Agency reexamined the subcategorization scheme for the nonintegrated segment of the pulp, paper, and paperboard industry and evaluated all available data for nonintegrated mills where fine papers are produced.

As shown below, EPA found that mills where a significant quantity of cotton fibers are contained in the product (equal to or greater than four percent of the total product) have significantly higher water usage and BOD5 raw waste loads than other nonintegrated mills where fine papers are produced.

Furnish	Average Raw Waste Load Flow	Average Raw Waste Load BOD5
All mills where the total product contains less than 4% cotton fibers	52.2 kl/kkg (12.5 kgal/ton)	10.9 kg/kkg (21.8 lb/ton)
All mills where the total product contains 4% or more cotton fibers	124.4 kl/kkg (29.8 kgal/ton)	18.0 kg/kkg (35.9 lb/ton)

The Agency concluded that mills where a significant quantity of cotton fibers are used in the raw material are substantially different from other mills in the nonintegrated-fine papers subcategory where only wood pulp is processed. Therefore, EPA established a separate cotton fibers subdivision of the nonintegrated-fine papers subcategory. Because the Agency has sufficient data to establish uniform national standards and limitations for this subcategory subdivision, EPA rejected the suggestion to rely on case-by-case limitations.

The Agency investigated industry's other contention that small mills have higher raw waste characteristics than the other mills in the nonintegrated-fine papers subcategory. EPA removed the eight mills where cotton fibers constitute a significant portion of the total product from the data base since they are now a separate subdivision of the nonintegrated-fine papers subcategory. (All of the cotton fiber mills are small in that less than 91 kkg (100 tons) of fine papers are produced per day.) EPA separated the remaining mills into the following groups: (a) mills where more than 91 kkg (100 tons) of paper are produced per day and (b) mills where less than 91 kkg (100 tons) of paper are produced per day. The raw waste loads for both groups are substantially the same. Therefore, no further subcategorization based on size is warranted.

Another group of nonintegrated mills where unique grades of products are manufactured could not be further divided into subcategories. Permits for these mills will continue to be established on a case-by-case basis.

MISCELLANEOUS MILLS

The subcategorization scheme does not account for all mills in each industry segment because of the complex variety of pulping processes employed, the different products manufactured, or because no subcategory exists within which a particular mill can be placed. Mills that do not logically fit the revised subcategorization scheme are included in miscellaneous mill groupings in each segment (integrated-miscellaneous, secondary fibers-miscellaneous, and nonintegrated-miscellaneous). Permits for all mills in the miscellaneous groupings will be established on a case-by-case basis. For many mills, permits can be written by prorating effluent limitations and standards from the appropriate subcategories; however, for other mills, this will not be possible because operations are employed that are not characteristic of any of the subcategory delineations.

IMPACT OF TOXIC POLLUTANT DATA

As discussed in Section II and in Section VI, EPA conducted toxic pollutant sampling programs to determine the level of toxic pollutants discharged from mills in each of the subcategories. This program was designed to take into account the revised subcategorization scheme. EPA reviewed the analytical results to determine if the revised subcategorization scheme adequately addresses toxic pollutant discharges. Available toxic pollutant data, summarized in Section VI, support the revised subcategorization scheme. Specific toxic pollutants are present in pulp, paper, and paperboard wastewaters because of the type of bleaching process employed (chloroform and zinc) or because of their addition as process chemicals (trichlorophenol and pentachlorophenol). The revised subcategorization scheme adequately accounts for the presence or generation of toxic pollutants and allows for establishment of effluent limitations and standards to ensure their control.

SUMMARY

In summary, after reviewing the original subcategorization scheme, EPA made several revisions. Four new subcategories were identified, while more subtle revisions have been made for several other subcategories (i.e., product allowances, adjustments for furnish used, allowances for percentage of pulp produced on-site). The revised subcategorization scheme is as follows:

Integrated

- Dissolving Kraft
- Market Bleached Kraft
- BCT (Board, Coarse, and Tissue) Bleached Kraft
- Fine Bleached Kraft
- Soda
- Unbleached Kraft
  - Linerboard
  - Bag and Other Products
- Semi-Chemical
- Unbleached Kraft and Semi-Chemical
- Dissolving Sulfite Pulp
  - Nitration
  - Viscose
  - Cellophane
  - Acetate
- Papergrade Sulfite (Blow Pit Wash)
- Papergrade Sulfite (Drum Wash)
- Groundwood-Thermo-Mechanical
- Groundwood - Coarse, Molded, and News (C, M, N) Papers
- Groundwood - Fine Papers
- Groundwood-Chemi-Mechanical

Secondary Fibers

- Deink
  - Fine Papers
  - Tissue Papers
  - Newsprint
- Tissue from Wastepaper
- Paperboard from Wastepaper
  - Corrugating Medium Furnish
  - Noncorrugating Medium Furnish
- Wastepaper-Molded Products
- Builders' Paper and Roofing Felt

Nonintegrated

- Nonintegrated-Fine Papers
  - Wood Fiber Furnish
  - Cotton Fiber Furnish
- Nonintegrated-Tissue Papers
- Nonintegrated-Lightweight Papers
  - Lightweight Papers
  - Lightweight Electrical Papers
- Nonintegrated-Filter and Nonwoven Papers
- Nonintegrated-Paperboard

The subcategories that form the basis of the promulgated regulations are defined as follows:

Dissolving Kraft

This subcategory includes mills where a highly bleached pulp is produced using a "full cook" process employing a highly alkaline sodium hydroxide and sodium sulfide cooking liquor. Included in the manufacturing process is a "pre-cook" operation termed pre-hydrolysis. The principal product is a highly bleached and purified dissolving pulp used principally for the manufacture of rayon and other products requiring the virtual absence of lignin and a very high alpha cellulose content.

Market Bleached Kraft

This subcategory includes mills where a bleached pulp is produced using a "full cook" process employing a highly alkaline sodium hydroxide and sodium sulfide cooking liquor. Papergrade market pulp is produced at mills representative of this subcategory.

BCT (Board, Coarse, and Tissue) Bleached Kraft

This subcategory includes the integrated production of bleached kraft pulp and board, coarse, and tissue papers. Bleached kraft pulp is produced on-site using a "full cook" process employing a highly alkaline sodium hydroxide and sodium sulfide cooking liquor. The principal products include paperboard (B), coarse papers (C), tissue papers (T), and market pulp.

Fine Bleached Kraft

This subcategory includes the integrated production of bleached kraft pulp and fine papers. Bleached kraft pulp is produced on-site using a "full cook" process employing a highly alkaline sodium hydroxide and sodium sulfide cooking liquor. The principal products are fine papers, which include business, writing, and printing papers, and market pulp.

Soda

This subcategory includes the integrated production of bleached soda pulp and fine papers. The bleached soda pulp is produced on-site using a "full cook" process employing a highly alkaline sodium hydroxide cooking liquor. The principal products are fine papers, which include printing, writing, and business papers, and market pulp.

Unbleached Kraft

This subcategory includes mills where pulp is produced without bleaching using a "full cook" process employing a highly alkaline sodium hydroxide and sodium sulfide cooking liquor. The pulp is used on-site to produce linerboard, the smooth facing in corrugated boxes, and bag papers.

Semi-Chemical

This subcategory includes mills where pulp is produced using a process that involves the cooking of wood chips under pressure using a variety of cooking liquors including neutral sulfite and combinations of soda ash and caustic soda. The cooked chips are usually refined before being converted on-site into board or similar products. The principal products include corrugating medium, insulating board, partition board, chip board, tube stock, and specialty boards.

Unbleached Kraft and Semi-Chemical

This subcategory includes mills where pulp is produced without bleaching using two pulping processes: unbleached kraft and semi-chemical. Spent semi-chemical cooking liquor is burned within the kraft chemical recovery system. The pulps are used on-site to produce both linerboard and corrugating medium used in the production of corrugated boxes and other products.

Dissolving Sulfite Pulp

This subcategory includes mills where a highly bleached and purified pulp is produced using a "full cook" process employing strong solutions of sulfites of calcium, magnesium, ammonia, or sodium. The pulps produced by this process are viscose, nitration, cellophane, or acetate grades and are used principally for the manufacture of rayon and other products that require the virtual absence of lignin.

Papergrade Sulfite (Blow Pit Wash)

This subcategory includes integrated production of sulfite pulp and paper. The sulfite pulp is produced on-site using a "full cook" process employing an acidic cooking liquor of sulfites of calcium, magnesium, ammonia, or sodium. Following the cooking operations, the spent cooking liquor is washed from the pulp in blow pits. The principal products include tissue papers, newsprint, fine papers, and market pulp.

Papergrade Sulfite (Drum Wash)

This subcategory includes the integrated production of sulfite pulp and paper. The sulfite pulp is produced on-site employing a "full cook" process using an acidic cooking liquor of sulfites of calcium, magnesium, ammonia, or sodium. Following the cooking operations, the spent cooking liquor is washed from the pulp on vacuum or pressure drums. Also included are mills using belt extraction systems for pulp washing. The principal products include tissue papers, fine papers, newsprint, and market pulp.

Groundwood - Thermo-Mechanical

This subcategory includes the production of thermo-mechanical groundwood pulp and paper. The thermo-mechanical groundwood pulp is produced on-site using a "brief cook" process employing steam, followed by mechanical defibration in refiners, resulting in yields of approximately 95% or greater. The pulp may be brightened using hydrosulfite or peroxide bleaching chemicals. The principal products include market pulp, fine papers, newsprint, and tissue papers.

Groundwood-CMN (Coarse, Molded, News) Papers

This subcategory includes the integrated production of groundwood pulp and paper. The groundwood pulp is produced, with or without brightening, utilizing only mechanical defibration using either stone grinders or refiners. The principal products made by this process include coarse papers (C), molded fiber products (M), and newsprint (N).

Groundwood-Fine Papers

This subcategory includes the integrated production of groundwood pulp and paper. The groundwood pulp is produced, with or without brightening, utilizing only mechanical defibration by either stone grinders or refiners. The principal products made by this process are fine papers which include business, writing, and printing papers.

Groundwood - Chemi-Mechanical

This subcategory includes the integrated production of chemi-mechanical groundwood pulp and paper. The chemi-mechanical groundwood pulp is produced using a chemical cooking liquor to partially cook the wood; the softened wood fibers are further processed by mechanical defibration using refiners, resulting in yields of 90 percent or greater. The pulp is produced with or without brightening. The principal products include fine papers, newsprint, and molded fiber products.

Deink

This subcategory includes the integrated production of deinked pulp and paper from wastepapers using a chemical or solvent process to remove contaminants such as ink and coating pigments. The deinked pulp is usually brightened or bleached. Principal products include printing, writing and business papers, tissue papers, and newsprint.

Tissue From Wastepaper

This subcategory includes the production of tissue papers from wastepapers without deinking. The principal products made include facial and toilet papers, paper diapers, and paper towels.

Paperboard from Wastepaper

This subcategory includes mills where paperboard products are manufactured from a wide variety of wastepapers such as corrugated boxes, box board, and newspapers; no bleaching is done on-site. Mills where paperboard products are manufactured principally or exclusively from virgin fiber are not included within this subcategory, which includes only those mills where wastepaper comprises the predominant portion of the raw material fibers. The principal products include a wide variety of items used in commercial packaging, such as bottle cartons.

Wastepaper-Molded Products

This subcategory includes mills where molded products are produced from wastepapers without deinking. Products include molded items such as fruit and vegetable packs and similar throw-away containers and display items.

Builders' Paper and Roofing Felt

This subcategory includes mills where heavy papers used in the construction industry are produced from cellulosic fibers derived from wastepaper, wood flour and sawdust, wood chips, and rags. Neither bleaching nor chemical pulping processes are employed on-site.

Nonintegrated-Fine Papers

This subcategory includes nonintegrated mills where fine papers are produced from purchased pulp. The principal products of this process are printing, writing, business, and technical papers.

Nonintegrated-Tissue Papers

This subcategory includes nonintegrated mills where tissue papers are produced from wood pulp or deinked pulp prepared at another site. The principal products made at these mills include facial and toilet papers, paper diapers, and paper towels.

Nonintegrated-Lightweight Papers

This subcategory includes nonintegrated mills where lightweight or thin papers are produced from wood pulp or secondary fibers prepared at another site and from nonwood fibers and additives. The principal products made at these mills include uncoated thin papers, such as carbonizing papers and cigarette papers, and some special grades of tissue such as capacitor, pattern, and interleaf.

Nonintegrated-Filter and Nonwoven Papers

This subcategory includes nonintegrated mills where filter papers and nonwoven items are produced from a furnish of wood pulp, secondary fibers, and nonwood fibers prepared at another site. The principal products made at these mills include filter and blotting papers, nonwoven packaging and specialties, and technical papers.

Nonintegrated-Paperboard

This subcategory includes nonintegrated mills where paperboard is produced from wood pulp or secondary fibers prepared at another site. The principal products made at these mills include linerboard, folding boxboard, milk cartons, food board, chip board, pressboard, and other specialty boards. Mills where electrical grades of board or matrix board are produced are not included in this subcategory.

SECTION V

WATER USE AND WASTE CHARACTERIZATION

WATER USE AND SOURCES OF WASTEWATER

Water is used in the following major unit operations employed in the manufacture of pulp, paper, and paperboard: wood preparation, pulping, bleaching, and papermaking. It can be used as a medium of transport, a cleaning agent, and a solvent or mixer.

Details of water use and sources of wastewater generation from each major production area in the pulp, paper, and paperboard industry are discussed below. Figure V-1 presents the water use and wastewater sources from a typical integrated mill.

Wood Preparation

Wood preparation operations can be employed at mills where wood pulp is manufactured on-site. Water is utilized in the wood preparation process in three basic areas: a) log transport, b) log and chip washing/thawing, and c) barking operations. Along with these basic uses, water can also be used to protect against fires (in chip and wood storage) and for storage of logs (in rivers or ponds).

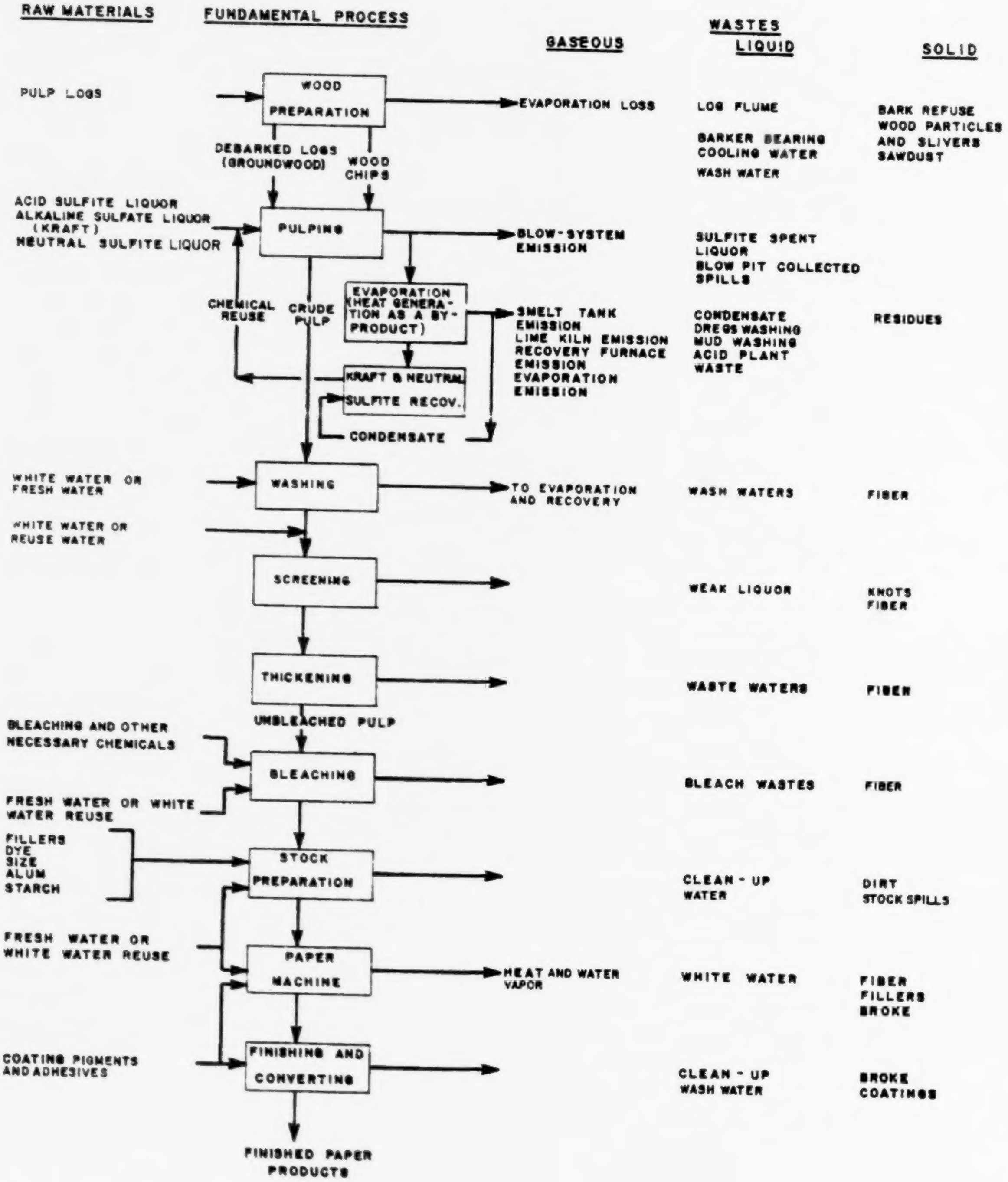
Water can be used to transport whole logs to the wood preparation area. This may take the form of river driving or flume transport. The only wastewater generated by log transport operations is the overflow from the transport flume.

In the log and chip washing/thawing operations, water is used in sprays or showers to remove salt, dirt, and debris; these showers can be activated by each log to minimize water use. Hot ponds are also used in cases where frozen logs need thawing prior to wood preparation.

Bark from whole logs is removed prior to chipping, and removal can be accomplished by dry or wet methods. In some cases, water is used as a presoak to soften bonds between the wood and bark prior to barking. Wet barking operations can utilize high volumes of water which can be used in three different ways: a) in high-pressure water jets (hydraulic) to strip away bark by impingement, b) in vats to facilitate cleaning, lubrication, and barking, and c) in showers to thaw frozen logs in the early stages of barking.

Wastewater discharged from all three types of wet barking can be combined with flume overflow or log or chip wash water; coarse screens can be used to remove large pieces of bark and wood slivers. Barking wastewater can then be passed through fine screens with the screenings combined with the coarse screening materials. The combined screenings can be dewatered in a press and burned in a bark boiler. This eliminates a source of solid waste while generating power.

FIGURE V-1
GENERAL FLOW SHEET
PULPING AND PAPERMAKING PROCESS


RAW MATERIALS
FUNDAMENTAL PROCESS
WASTES
GASEOUS
LIQUID
SOLID
PULP LOGS
WOOD PREPARATION
EVAPORATION LOSS
LOG FLUME
BARKER BEARING COOLING WATER
WASH WATER
BARK REFUSE
WOOD PARTICLES AND SLIVERS
SAWDUST
DEBARKED LOGS (GROUNDWOOD)
WOOD CHIPS
ACID SULFITE LIQUOR
ALKALINE SULFATE LIQUOR (KRAFT)
NEUTRAL SULFITE LIQUOR
PULPING
BLOW-SYSTEM EMISSION
SULFITE SPENT LIQUOR
BLOW PIT COLLECTED SPILLS
CHEMICAL REUSE
CRUDE PULP
EVAPORATION (HEAT GENERATION AS A BY-PRODUCT)
SMELT TANK EMISSION
LIME KILN EMISSION
RECOVERY FURNACE EMISSION
EVAPORATION EMISSION
CONDENSATE
DREGS WASHING
MUD WASHING
ACID PLANT WASTE
RESIDUES
KRAFT & NEUTRAL SULFITE RECOV.
CONDENSATE
WHITE WATER OR FRESH WATER
WASHING
TO EVAPORATION AND RECOVERY
WASH WATERS
FIBER
WHITE WATER OR REUSE WATER
SCREENING
WEAK LIQUOR
KNOTS
FIBER
THICKENING
WASTE WATERS
FIBER
UNBLEACHED PULP
BLEACHING AND OTHER NECESSARY CHEMICALS
BLEACHING
FRESH WATER OR WHITE WATER REUSE
BLEACH WASTES
FIBER
FILLERS
DYE
SIZE
ALUM
STARCH
STOCK PREPARATION
CLEAN-UP WATER
DIRT
STOCK SPILLS
FRESH WATER OR WHITE WATER REUSE
PAPER MACHINE
HEAT AND WATER VAPOR
WHITE WATER
FIBER
FILLERS
BROKE
COATING PIGMENTS AND ADHESIVES
FINISHING AND CONVERTING
CLEAN-UP WASH WATER
BROKE
COATINGS
FINISHED PAPER PRODUCTS

Pulping and Recovery

In pulping operations, water is used as make-up, for dilution, and for washing and cleaning. It can also be used to facilitate a process mechanism, such as fiberization. With each different pulping process, the demand and sources of wastewater discharge vary. They are discussed separately below.

Mechanical Pulping (Groundwood). The two basic processes in groundwood or mechanical pulping are the stone groundwood process and the refiner groundwood process. These processes have also been modified through the addition of steam and/or chemicals to reduce power requirements for grinding. These newer processes are known as the thermo-mechanical process and the chemi-mechanical process.

In stone groundwood pulping, billets are fed to grinders by hand or automatically from a conveyor. Water is used as both a coolant and a carrier to sluice pulp from the body of the grinder. More water is added to dilute the pulp slurry, which is passed through coarse and fine screens and centricleaners to remove dirt and slivers. The pulp slurry is thickened on a decker and then discharged to a stock chest for mill use, to be bleached, or to be thickened further for transport. Wastewater from the thickening processes can be recycled back to a white water chest to supplement process water flow to the grinders. Overflow from the white water chest and wastewater from the centricleaners are usually discharged to the treatment system.

In refiner groundwood pulping, wood chips are generally washed prior to two stages of refining. Disc type refiners are used which may contain one fixed and one rotary disc (or two rotary discs) between which wood chips pass with a stream of water. After the pulp has passed through the refiners, it is diluted with water, screened, and cleaned in centricleaners. After cleaning, the pulp is handled in the same manner as stone groundwood. Wastewater sources can include the white water tank overflow, thickening wastewater, centricleaner wastewater, and wood chip wash water.

In chemi-mechanical pulping, logs or wood chips are soaked or cooked in liquor containing different chemicals such as sodium carbonate, sodium hydroxide, and sodium sulfite. This can be done at atmospheric pressure or under forced pressure for shorter periods of time. After this treatment, the logs or chips are handled in a manner similar to that used in stone or refiner groundwood pulping. Wastewater sources are the same as those for stone or refiner groundwood pulping.

In thermo-mechanical pulping, wood chips are pre-softened with heat and refined under pressure. After this treatment, chips are handled in the same manner as stone or refiner groundwood pulping and the potential wastewater sources are identical.

Chemical Pulping. Chemical pulping involves the use of controlled conditions and cooking chemicals to yield a variety of pulps. Chemical pulps are converted into paper products that generally have higher quality standards than products made from mechanical pulps. The three basic types of chemical pulping are alkaline (soda or kraft), sulfite, and semi-chemical pulping.

Kraft pulping was originally developed from the soda process. In the soda process, wood chips are cooked in a digester in a solution of caustic soda. When cooking is completed, the contents of the digester are blown into a tank. The pulp is washed on countercurrent drum washers and then diluted with water, screened, and deckered to stock chest consistency. Wastewater sources include spills from the digester area, condensed digester vapors, and wastewater from the washing, screening, and deckering operations.

In the kraft pulping process, wood chips are cooked in a solution consisting primarily of a mixture of caustic soda and sodium sulfide which is known as white liquor. Both batch and continuous digesters can be employed. In the manufacture of dissolving pulps, the wood chips are sometimes steamed in the digester for a short period prior to the addition of the cooking liquor. This is known as pre-hydrolysis. In this step, the chips are loaded into the digester which is then partially or totally filled with water, and the whole mass is heated. As the temperature rises, wood acids are released, the pH drops, and the acidic conditions degrade and solubilize the hemi-cellulose molecules in the wood. After about two hours, the acidic sugar-rich liquors are drained and the kraft liquor is introduced into the digester to start the cooking stage.

When cooking is completed, the chips are blown from the digester to a tank where they separate into fibers. Steam from the tank goes to an accumulator for heating process water. Drainings can be returned to the white liquor storage tank to be used in succeeding cooks. The pulp is transferred, along with the spent cooking liquor or "black liquor", to a "brown stock" chest or tank, and from there to vacuum drum washers or continuous diffusers where spent liquor is separated by countercurrent washing. In order to optimize chemical recovery, three or sometimes four stages of washing are used to allow a high degree of liquor separation with a minimum amount of dilution. This reduces the heat requirements of evaporation in the chemical recovery operation. Where continuous digesters equipped with internal diffusion washing are used, only one or two external washing steps may be employed.

After washing, the pulp is diluted, screened, and deckered to a consistency suitable for bleaching. Wastewater sources from the kraft pulping process can include spills from the digester area, digester relief and blow condensates, wastewater from the "brown stock" washers, and wastewater from the screen room and deckers.

Wastewater is also generated in the kraft liquor recovery system. The liquor recovered from the washing operation is called "weak black liquor." This weak black liquor is concentrated in multiple effect evaporators into a viscous mass called "strong black liquor." The strong black liquor is further concentrated in the recovery furnace direct contact evaporator or in a concentrator. The strong black liquor is burned and the heat is recovered. During burning, the organic sodium compounds are converted to soda ash and sulfates are converted to sulfides. The molten smelt of salts is dissolved in water to form "green liquor." The green liquor is clarified and causticized with lime to convert the soda ash to caustic soda. After causticizing, the combined sodium sulfide-caustic soda solution, known as "white liquor," is settled, sometimes filtered through press filters, and reused. The lime mud (calcium carbonate) obtained after settling the white liquor is washed and dewatered on rotary vacuum filters or centrifuges and burned in rotary or fluidized bed kilns to form quick lime. This is hydrated with green liquor in slakers for reintroduction into the recovery cycle. The wastewater from the vacuum filters or centrifuges is discharged to the wastewater treatment system.

The sulfite process is used to make two distinctly different types of pulp: papergrade and dissolving grade. The basic process is the same for both, although there are significant differences in cooking temperatures, strength of chemical application, and bleaching practices. In the preparation of dissolving sulfite pulps, cooking is continued until most of the lignin and part of the cellulose and hemi-cellulose are dissolved. In making papergrade pulps, essentially only the lignin is dissolved; final net yield is several percent higher than for dissolving pulps.

In the sulfite process, wood chips are cooked with solutions of the sulfites of calcium, magnesium, ammonia, or sodium. The cooking liquor is manufactured at the mill from purchased and recovered chemicals. Sulfurous acid is prepared by absorbing sulfur dioxide in water. Sulfur dioxide is made at the mill by burning sulfur or is purchased in liquid form; both forms can be supplemented by sulphur dioxide from the recovery system. Process water is used to cool the sulfur dioxide gas produced. Sulfurous acid is used in preparation with calcium carbonate and calcium oxide or aqua ammonia for the manufacture of cooking liquor. Neither calcium nor ammonia is recovered. Magnesium oxide and caustic soda are purchased as make-up base chemicals for the magnesium and sodium base recovery systems which recover about 90 percent of the base chemicals.

When ammonia, calcium, magnesium, or sodium base cooking is completed, the pulp is blown into a blow tank. It is then delivered to multi-stage vacuum (drum) washers, where countercurrent washing separates the spent liquor from the pulp. Blow pits rather than blow tanks can be employed; in blow pits, pulp is washed by diffusion of wash water through the pulp mass. Blow pit washing can be supplemented with vacuum (drum) washing to increase washing efficiency.

After washing, the pulp is diluted, screened, centrifugally cleaned, and deckered to the desired stock chest consistency for bleaching. In the manufacture of dissolving sulfite pulps, an extra set of "side-hill" screens are used for thickening and to separate resinous materials. The wastewater sources from the sulfite process include digester area spills, digester relief and blow condensates, and water losses from the vacuum (drum) or blow pit washing and screening and deckering operations.

Wastewater is also discharged from the recovery system. The weak "red liquor" washed from the pulp is evaporated to a consistency suitable for burning. Some evaporator condensate is discharged to the sewer, while the rest may be used for washing and stock dilution.

Historically, semi-chemical pulping has involved the cooking of wood chips in a solution containing sodium sulfite. As discussed in Section III, the semi-chemical process can be modified to include non-sulfur containing solutions of soda ash and caustic soda. Wood chips are cooked at high temperatures for a period of about 10 to 20 minutes or at lower temperatures for longer periods of time (generally, one to three hours). After cooking, the softened chips are sometimes compressed in one or more stages of screw pressing to maximize the recovery of spent liquor. The cooked chips are then transferred to a disc mill for fiberization. The chips then undergo vacuum or pressure washing and screening and/or centrifugal cleaning. The pulp is conveyed to an agitated chest where it is diluted with white water from the paper mill. Wastewater sources include digester area spills, digester relief and blow condensates, and water losses from the screw press, washing, and screening operations.

Chemical recovery in the sodium-based NSSC process is considerably more difficult than in the kraft process. The spent liquor is low in solids with a relatively high proportion of inorganic to organic constituents and does not burn easily. At many mills, spent liquor is evaporated and burned without recovery of the chemical base. Evaporation is commonly accomplished in multiple-effect evaporators. The concentrated liquor is burned for disposal or recovery in a fluidized bed reactor or a specially-designed furnace. In sodium-based mills, the fluidized bed combustion units produce sodium sulfate which is suitable for use in kraft mill liquor systems. No successful system has been developed for ammonia recovery at ammonia-based NSSC mills; the spent liquor is simply incinerated to recover energy.

The no-sulfur semi-chemical processes allow for recovery of soda ash after burning of spent liquor in a modified kraft-type furnace or fluidized bed. The recovered chemical is recycled to the digester; caustic make-up provides a balanced pH for liquor reuse. In any semi-chemical recovery system, evaporator condensate may be sewered.

Secondary Fiber Pulping. Secondary fiber sources, such as wastepaper of various classifications, can be used to make several grades of pulp. Some wastepaper can be used with little or no preparation, particularly if wastepaper is purchased directly from other mills or converting operations where a similiar product grade is manufactured. However, some wastepaper is deinked before it is used as a pulp source.

In the deinking process, wastepaper is cooked in an alkaline solution to which dispersants, detergents, and solvents are added. The process is essentially a laundering operation in which the sizes, any coating binder, and the pigment vehicle in the ink are dissolved or dispersed; the ink pigment is released along with filler and coating agents such as clay, calcium carbonate, and titanium dioxide. Adhesives such as starch and glue are also dissolved and dispersed. The wastepaper is then cooked in a pulper with cooking time determined by examination of a sample from the pulper. During this step, a trash boot and a ragger may be used to remove such items as trash, rags, rope, and wire. The stock is then usually screened, after which it is ready for cleaning. This is accomplished by passing the stock through centricleaners and fine screens. Generally countercurrent washing is employed on washers of various types. Flotation is employed at some mills for separating the fiber from the undesirable materials; at others, various kinds of deckering or thickening equipment are used. Fiber leaves the washers and is delivered to a stock chest. Wastewater sources in deink pulping include wastewater from the centrifugal cleaners, washers, deckers, and thickeners and spills from the deinking process area.

In non-deinking operations, some wastepaper can be slushed or blended with virgin pulps to provide suitable furnish for the papermachine. The combined stock is generally cleaned and screened in the stock preparation system in the papermachine area. In other non-deinking operations, considerable quantities of books, envelope cuttings, flyleaf shavings, and similar unprinted scrap are repulped and washed free of fillers, adhesives, and sizing material; any ink removal is incidental. Wastewater sources are similar to those in the deinking process.

Bleaching

After pulping, the unbleached pulp can be brown or deeply colored because of the presence of lignins and resins or because of inefficient washing of the spent cooking liquor from the pulp. In order to remove or brighten these color bodies and to produce a lightly-colored or white product, it is necessary to bleach the pulp.

Bleaching of Mechanical (Groundwood) Pulp. The most common bleaching agents used for stone and refiner groundwood are hydrosulfites and peroxides; both can be used sequentially. In peroxide bleaching, hydrogen or sodium peroxide is applied to the pulp in a mixing tank along with caustic soda or other chemicals to raise the pH. Steam is fed to the mixing tank to heat the mixture to the proper temperature; pulp is then fed to a peroxide bleaching tower. After bleaching in the tower, the pulp is usually neutralized to prevent reversal of the reaction. Sometimes, if further brightening is required, a hydrosulfite bleaching step follows peroxide bleaching.

Sodium or zinc hydrosulfite can be used in the same manner as peroxide. Both acidic conditions and the presence of air in solution decrease bleaching effectiveness. Wastewater discharge is limited to that resulting from the washing of bleached mechanical pulp subsequent to the peroxide or hydrosulfite bleaching step.

Bleaching of Chemical Pulp. The chemicals most commonly employed for bleaching of chemical pulps are chlorine, calcium or sodium hypochlorite, and chlorine dioxide. Alkaline solutions of caustic soda are used for extracting chlorinated reaction products from treated pulp. Hydrogen peroxide, sodium peroxide, or peroxyacetic acid can be used in the finishing stages of bleaching. Sulfur dioxide or sodium sulfite can be used as neutralizing and anti-chlor reagents and in some instances to stabilize pulp brightness. However, the chlorine compounds and alkalis are the most commonly applied chemicals.

Chlorine and caustic soda are generally purchased in liquid form, but can be manufactured at the mill by electrolysis of sodium chloride. Hypochlorites are generally manufactured on-site by treatment of milk of lime or caustic soda with chlorine. Chlorine dioxide is manufactured on-site because of its instability. Other bleaching chemicals are purchased in their common form; solutions are prepared according to process needs. These are employed in relatively small quantities as compared to the major bleaching agents.

Bleaching is ordinarily performed in a number of stages. This is done to preserve the strength of the pulp by avoiding excessively rigorous chemical treatment and to control consistency and temperature in accordance with the demands of the particular treatment application. Each stage consists of a reaction tower in which the pulp is retained in contact with a particular chemical agent for a specified period of time. It is then washed on vacuum washers or diffusers and discharged to the next stage.

The chemical concentrations employed depend upon the consistency, temperature, number of stages, specific chemicals used, species of wood from which the pulp was produced, degree to which it was cooked, and quality of product desired. Three stages are generally used in semibleached kraft operations and for bleaching of sulfite papergrade pulps. Since kraft pulps are dark in color, particularly when made from softwoods, high-brightness kraft pulps usually require more stages. Normally five are used, although at some mills six or more stages are used. Three stages may be used for low-brightness soda pulp and four stages for high brightness.

Wastewater is generated in the preparation of both hypochlorite and chlorine dioxide and is discharged from the bleach plant from the first stage chlorine tower wash system and the first stage caustic extraction wash tower.

Displacement bleaching is a new process which is being installed at some U.S. mills. Bleaching chemicals are displaced through a high consistency pulp mat rather than being conventionally mixed into the pulp. Very rapid bleaching can be accomplished due to high reaction rates. Filtrate withdrawal at one stage is fortified with make-up chemical and reused. The bleaching stages can be located within a single displacement tower. The major reactor is chlorine dioxide followed by extraction with caustic soda. Wastewater sources include the wastewater from preparation of chlorine dioxide and wash water introduced on the alkaline and acidic (ClO_2) stages.

Bleaching of Deinked Secondary Fibers. Deinked fibers consisting primarily of bleached chemical pulp are bleached in one stage with chlorine or calcium or sodium hypochlorite. When pulps containing considerable lignin are bleached after deinking, the three-stage CED process (chlorination, caustic extraction, and chlorine dioxide), commonly applied to kraft and sulfite pulps, is employed. In this process, chlorine is applied to a dilute slurry of the pulp at ambient temperature. The pulp is then thickened and treated with caustic soda, washed, and treated with hypochlorite. A variety of equipment and variations of this process are in use. When pulps containing mostly groundwood are bleached, bleaching methods similar to those used to bleach groundwood pulp are used; common bleaching chemicals include peroxides and hydrosulfites.

Wastewater sources for bleaching of deinked pulps are similar to those associated with the bleaching of other papergrade pulps. In the case of pulps containing large amounts of lignin, wastewater discharge includes chlorination and caustic extraction wash water. In the case of secondary fibers containing high groundwood or chemical pulp, wastewater discharge includes wash water resulting from a single wash stage.

Papermaking

In stock preparation, pulp, either purchased (nonintegrated mills) or produced on-site (integrated or secondary fiber mills), is resuspended in water. The stock is mechanically treated in beaters or continuous refiners to "brush" or fray the individual fibers to obtain the necessary matting and bonding which produces the desired strength in the paper. This process also cuts the fibers to some degree. Chemical additives may be added either before or after stock preparation.

Either a Fourdrinier or cylinder forming machine may be used to make paper or paperboard. The primary operational difference between the two types is the flat sheet-forming surface of the Fourdrinier and the cylindrical-shaped mold of the cylinder machine. The type of machine used has little bearing on the raw waste load. Because of its higher speed and greater versatility, the Fourdrinier is in more common use than the cylinder machine. The cylinder machine is primarily used to produce thick, heavyweight board products.

Water is used for dilution and to transport pulp to the paper machine. This water, called "white water" drains or is pressed from the paper or paperboard on the "wet end" of the paper machine. White water is of relatively high quality and is normally reused on the paper machine or in other areas of the mill. Wastewater sources in the papermaking operation include water losses from the stock preparation area and white water from the Fourdrinier or cylinder machine which overflows the white water recycle tank.

WASTE CHARACTERIZATION STRATEGY

The purpose of this section is to present information on the wastewater characteristics of mills in the subcategories identified in Section IV. As outlined previously, three categories of pollutants were under investigation: a) conventional pollutants, b) toxic pollutants, and c) nonconventional pollutants. [When presenting data in the tables that appear in this section, wastewater data in metric units are conversions of parallel data in English units. However, BPT raw waste characteristics are precisely those values published in this and previous documents supporting development of BPT effluent limitations guidelines.]

Conventional Pollutants

The Clean Water Act defined four conventional pollutants or pollutant parameters: BOD_5, TSS, pH, and fecal coliform. An additional pollutant, oil and grease, was defined by EPA as a conventional pollutant under procedures established in section 304 of the Clean Water Act. As a result of past efforts, effluent limitations have been established for the control of BOD_5, TSS, and pH in discharges from the pulp, paper, and paperboard industry.

Information on the raw waste characteristics of mills in each of the subcategories of the pulp, paper, and paperboard industry was gathered as part of the data request program described in Section II and is presented in this section.

Dissolving Kraft. Table V-1 presents available data on wastewater discharge and raw waste loadings of BOD_5 and TSS at mills representative of the dissolving kraft subcategory. At these mills, blends of dissolving pulps and papergrade market pulps are produced. Raw material usage ranges from 100 percent hardwood to 100 percent softwood. At one mill, a blend of 88 percent softwood and 12 percent hardwood is used. The proportion of dissolving pulp ranges from 49 to 72 percent with an overall average of 60 percent. Bleaching sequences and practices vary on different lines at the individual mills. However, at all three, jump-stage countercurrent washing is generally practiced. Calculated bleached yield averages about 40 percent for the softwood and 46 percent for the hardwood pulps.

TABLE V-1

SUMMARY RAW WASTE LOAD DATA
DISSOLVING KRAFT SUBCATEGORY

	Production Profile		Raw Waste Load						
			Flow		BOD5		TSS		
Mill No.	Raw Material	Dissolving Pulp (%)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≤BPT(a)
032001(b)	100% HW	72	136.9	(32.8)	109.5	(219.0)	120.4	(240.7)	F
032002(b)	100% SW	49	218.2	(52.3)	39.4	(78.7)	132.0	(264.0)	BF
032003(b)	88% SW	59	239.1	(57.3)	59.8	(119.6)	81.6	(163.2)	B
Average		60	198.2	(47.5)	69.6	(139.1)	111.3	(222.6)	
BPT Raw Waste Load			230.0	(55.1)	66.5	(133.0)	113.0	(226.0)	

(a)F - Mill with ≤BPT flow; B - Mill with ≤BPT BOD5.

(b)Production data held confidential.

In order to evaluate the effect of the fraction of dissolving pulp produced on raw waste load, raw waste flow and BOD5 have been plotted in Figures V-2 and V-3 against the percentage of dissolving pulp produced relative to total product manufactured on-site. Although no relationship appears to exist for flow, BOD5 increases with increasing percent of dissolving pulp produced. In addition, the effect of pulping softwood versus hardwood on raw waste load has been evaluated by plotting raw waste flow and BOD5 against percent softwood in Figure V-4. It has been suggested that raw waste loads would increase with an increase in the percentage of softwood processed. However, the highest BOD5 raw waste load occurs at the mill where only hardwood is pulped. It must be noted that the highest percentage of dissolving pulp relative to total final product is produced at this mill.

Further review of operating variables at the three mills indicates that washing efficiency has a greater effect on BOD5 raw waste load than either the amount of dissolving pulp produced or the percentage of softwood pulped. The salt cake loss, as washable Na2O, was higher at the mill where the BOD5 raw waste load was highest (e.g., the mill where only hardwood is pulped). Based on the limited data available, it was impossible to determine a specific relationship between raw waste flow and BOD5 relative to either the percentage of dissolving pulp produced or the percentage of softwood pulped.

Market Bleached Kraft. Table V-2 presents available data on wastewater discharge and raw waste BOD5 and TSS at mills representative of the market bleached kraft subcategory. Raw material use ranges from 100 percent hardwood to 100 percent softwood. Production ratios can and do shift and the capability generally exists to pulp all softwood if desired. To aid in identifying trends with respect to raw waste load, the mills are listed sequentially in the order of increasing softwood pulping. Figures V-5 and V-6 present plots of the raw waste flow and BOD5 versus the percentage of softwood pulped. A trend is apparent with respect to raw waste load flow and BOD5, with both generally increasing slightly as the production of softwood increases. However, regression analysis of the relationship of flow and BOD5 versus percent softwood was inconclusive and no definite relationship could be established.

BCT (Paperboard, Coarse, and Tissue) Bleached Kraft. Table V-3 presents available data on wastewater discharge and BOD5 and TSS raw waste loads at the eight mills representative of the BCT (paperboard, coarse, and tissue) bleached kraft subcategory. At mills in this subcategory, bleached kraft pulps are produced for the on-site production of paperboard, market pulp, and tissue and coarse grades of paper. At most of the mills, both hardwood and softwood pulps are produced; however, at two, only softwood pulp is used in the production of tissue and board products. Figures V-7 and V-8 present plots of raw waste flow and BOD5 with respect to the percentage of softwood pulp in the furnish. Based on a statistical analysis of the data, no significant correlation could be established between either raw waste flow or BOD5 and the percentage of softwood pulped.

FIGURE V-2
RAW WASTE FLOW VERSUS PERCENT DISSOLVING PULP
DISSOLVING KRAFT SUBCATEGORY

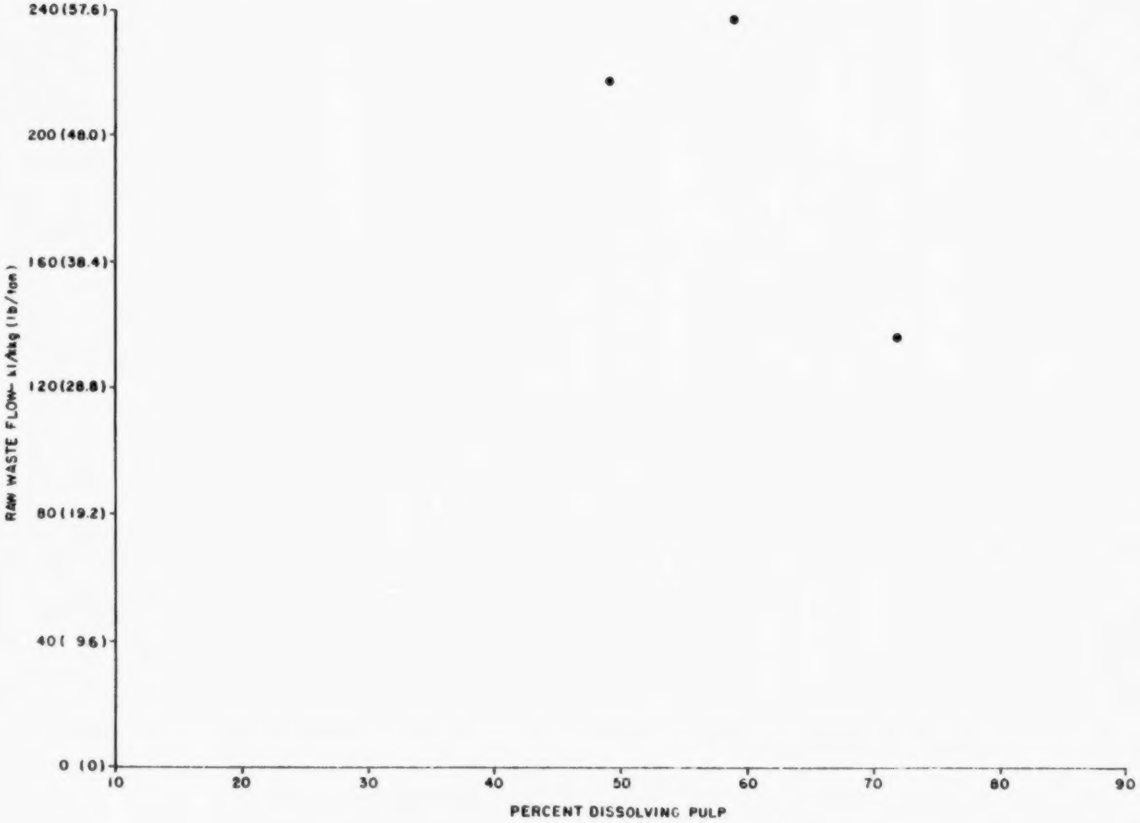


FIGURE V-3
RAW WASTE BOD$_5$ VERSUS PERCENT DISSOLVING PULP
DISSOLVING KRAFT SUBCATEGORY

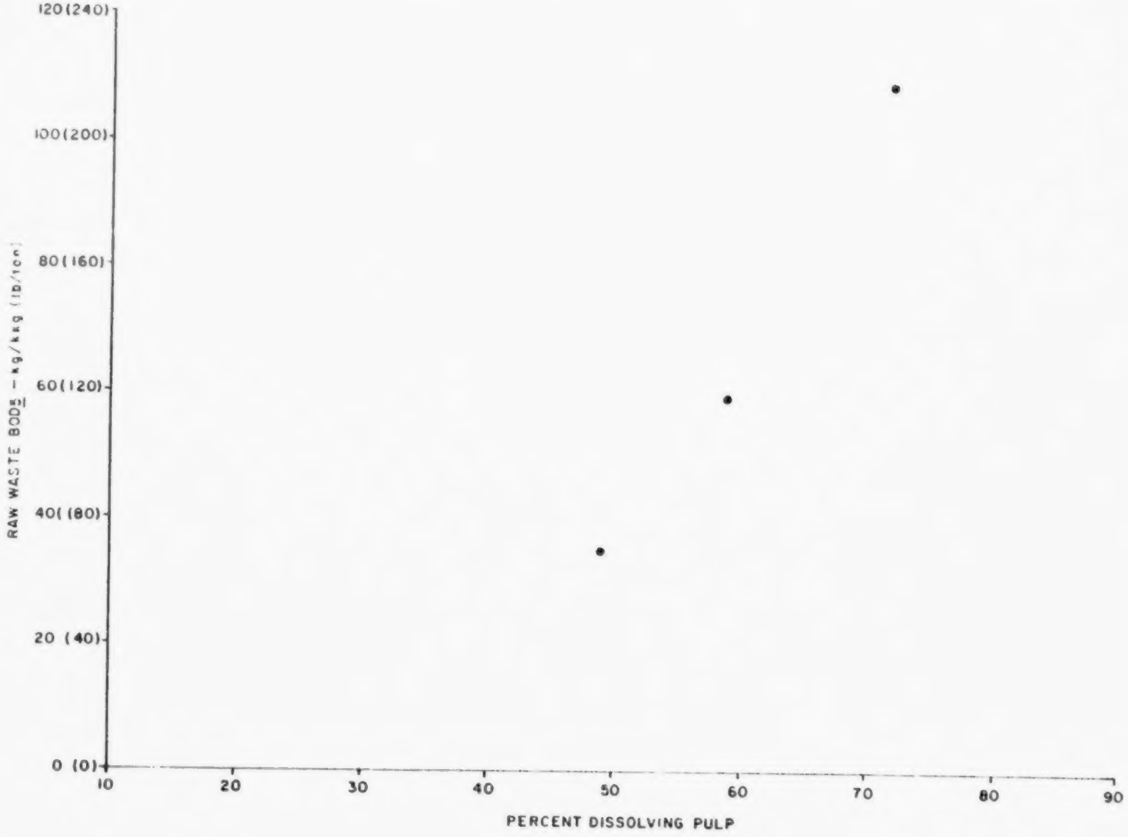


FIGURE V-4
RAW WASTE DATA (FLOW AND BOD$_5$)
VERSUS PERCENT SOFTWOOD USED
DISSOLVING KRAFT SUBCATEGORY

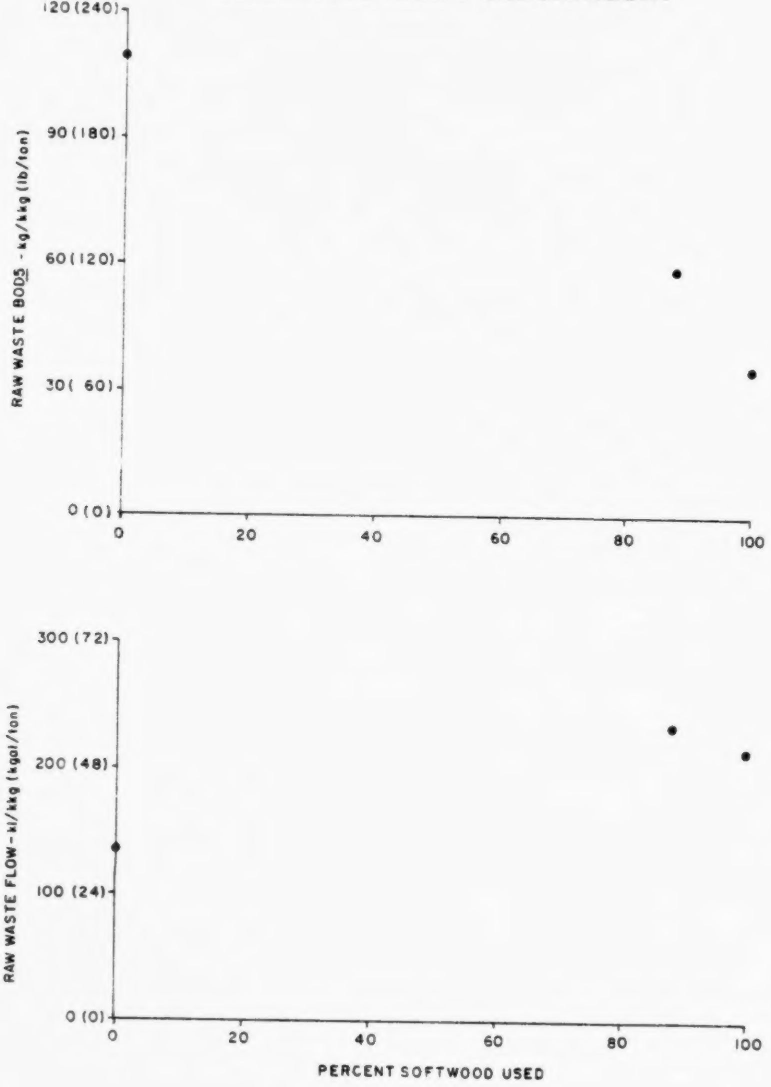


TABLE V-2

SUMMARY RAW WASTE LOAD DATA
MARKET BLEACHED KRAFT SUBCATEGORY

	Production Profile				Raw Waste Load						
	Pulp				Flow		BOD5		TSS		
Mill No.	HWK(%)	SWK(%)	Product	(t/d)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≤BPT(c)
030005	100	-	bales	369	73.4	(17.6)	17.5	(35.0)	20.4	(40.8)	BF
030009	100	-	bales	592	135.2	(32.4)	--	(--)	--	(--)	F
030012	89	11	bales	(a)	153.1	(36.7)	35.7	(71.4)	98.0	(195.9)	BF
030042	64	36	slush	409	78.5	(18.8)	37.4	(74.8)	14.4	(28.7)	BF
030028	27	73	board/ bales	(a)	154.4	(37.0)	35.5	(71.0)	24.0	(47.9)	BF
030031	26	74	bales	341	333.0	(79.8)	44.0	(88.0)	132.0	(264.0)	
030030	21	79	bales	723	169.4	(40.6)	44.1	(88.1)	24.7	(49.4)	F
030018	11	89	bales	(a)	184.9	(44.3)	39.2	(78.3)	48.4	(96.8)	
030006	0	100	bales	582	179.9	(43.1)	41.3	(82.5)	22.4	(44.7)	
900074(b)	0	100	unknown	515	134.8	(32.3)	23.1	(46.2)	18.7	(37.4)	BF
Average					159.8	(38.3)	35.3	(70.6)	44.8	(89.5)	
BPT Raw Waste Load					173.0	(41.6)	38.0	(75.9)	45.0	(90.0)	
Average of Mills with ≤BPT flow					128.5	(30.8)	32.2	(64.4)	33.4	(66.7)	
Average of Mills >70% SWK					192.8	(46.2)	37.9	(75.7)	45.0	(90.0)	
Average of Mills >70% SWK and ≤BPT flow					152.7	(36.6)	34.2	(68.4)	22.5	(44.9)	
Average of Mills >70% HWK					120.6	(28.9)	26.6	(53.2)	59.2	(118.4)	
Average of Mills >70% HWK and ≤BPT flow					120.6	(28.9)	26.6	(53.2)	59.2	(118.4)	
Average of Mills >70% HWK and ≤BPT BOD5					120.6	(28.9)	26.6	(53.2)	59.2	(118.4)	
Average of Mills >70% SWK and ≤BPT BOD5					144.8	(34.7)	29.3	(58.6)	21.4	(42.7)	

(a)Production data held confidential.
(b)Supplemental data (not from 308).
(c)F - Mill with ≤BPT flow; B - Mill with ≤BPT BOD5.

FIGURE V-5
RAW WASTE FLOW VERSUS PERCENT SOFTWOOD USED MARKET BLEACHED KRAFT SUBCATEGORY

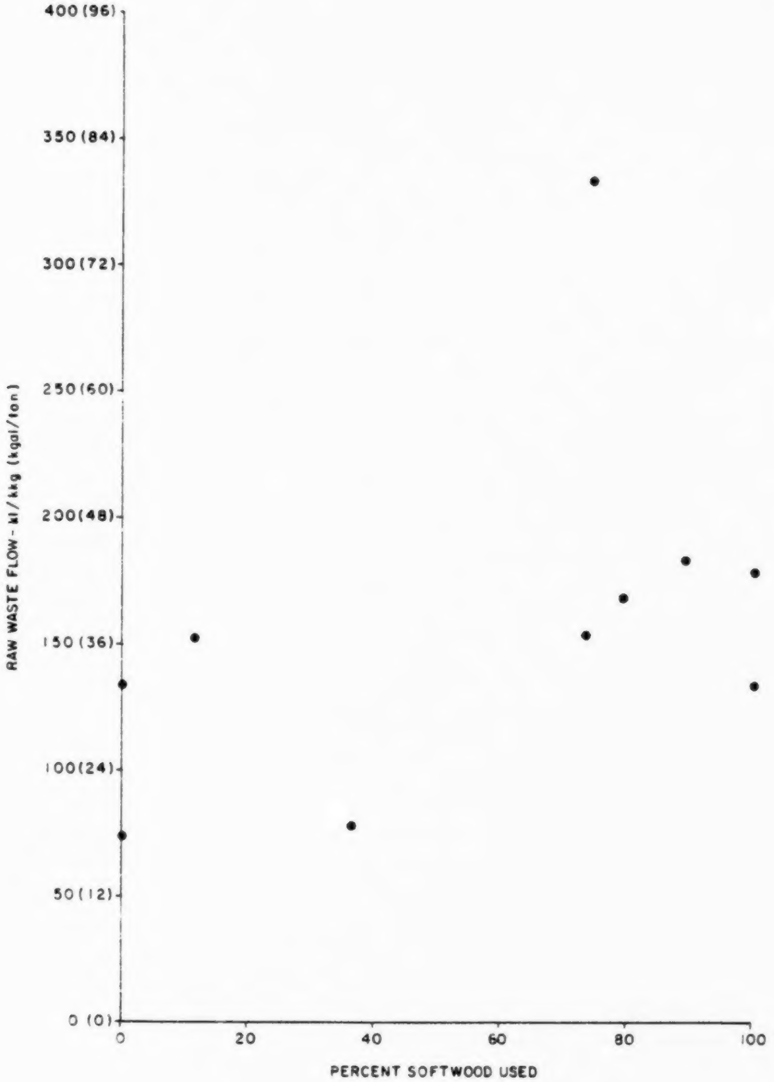


FIGURE V-6
RAW WASTE BOD5 VERSUS PERCENT SOFTWOOD USED
MARKET BLEACHED KRAFT SUBCATEGORY

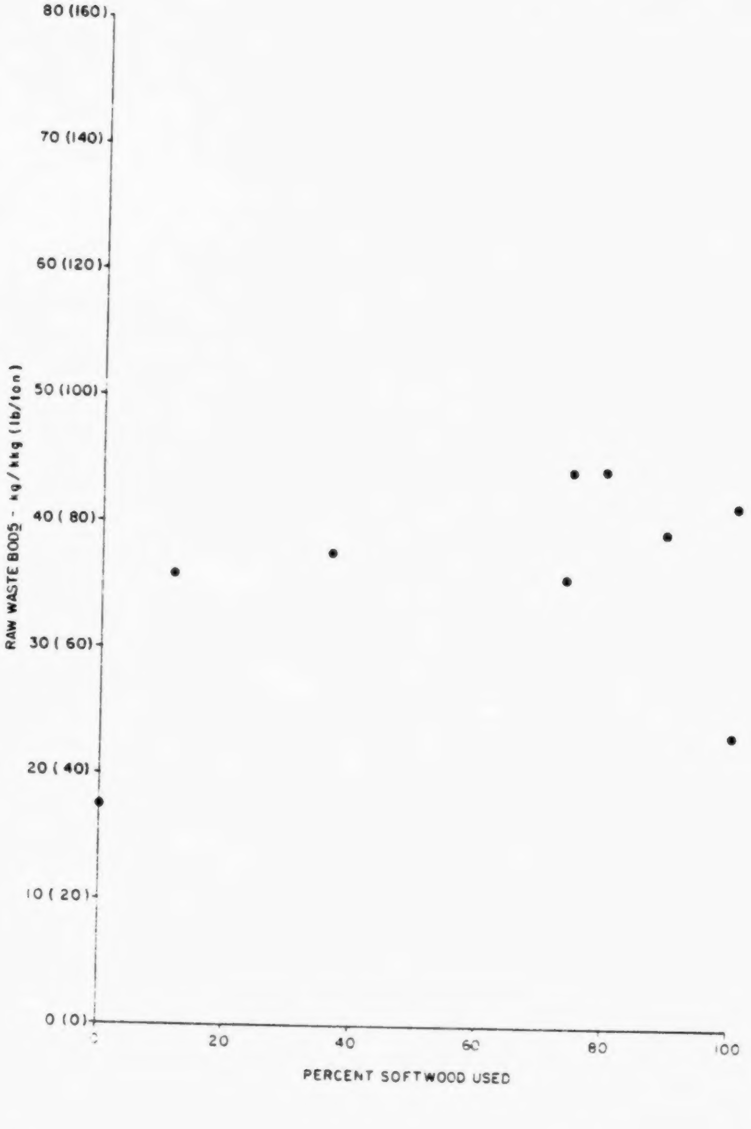


TABLE V-3

SUMMARY RAW WASTE LOAD DATA
BCT BLEACHED KRAFT SUBCATEGORY

	Production Profile						Raw Waste Load						
	Pulp (t/d)		Product (t/d)				Flow		BOD5		TSS		
Mill No.	HW	SW	Board	Tissue	Market & Coarse	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≤BPT(d)
030004	436	535	548	343	69	960	187.0	(44.8)	57.3	(114.6)	41.7	(83.3)	
030010	--	335	--	231	84	315	187.0	(44.8)	37.2	(74.3)	42.9	(85.7)	B
030022	352	943	907	--	394(c)	1301	150.6	(36.1)	33.0	(66.0)	--	(--)	B
030024	512	368	714	--	106	820	137.7	(33.0)	57.5	(115.0)	--	(--)	F
030026(a)	--	1073	884	59	210	1153	121.0	(29.0)	46.3	(92.5)	33.2	(66.3)	F
030047	306	204	583	--	--	583	131.4	(31.5)	64.1	(128.2)	79.5	(159.0)	F
030032	584	576	895	--	348	1243	138.1	(33.1)	42.6	(85.2)	48.3	(96.5)	F
030039(b)	291	238	487	--	107	594	92.2	(22.1)	29.2	(58.4)	24.0	(47.9)	
Average							150.2	(36.0)	48.3	(96.5)	49.1	(98.2)	
BPT Raw Waste Load							148.0	(35.4)	38.4	(76.7)	66.5	(133.0)	
Average of Mills with ≤BPT flow							132.3	(31.7)	52.6	(105.2)	53.7	(107.3)	
Average of Mills with ≤BPT BOD5							169.0	(40.5)	35.1	(70.2)	42.9	(85.7)	

(a)Includes lumber mill effluent in raw waste figures.
(b)Waste load data reported are secondary influent; not included in averages.
(c)236 t/d market, 158 t/d writing and related papers.
(d)F - Mill with ≤BPT flow; B - Mill with ≤BPT BOD5.

FIGURE V-7
RAW WASTE FLOW VERSUS PERCENT SOFTWOOD USED
BCT BLEACHED KRAFT SUBCATEGORY

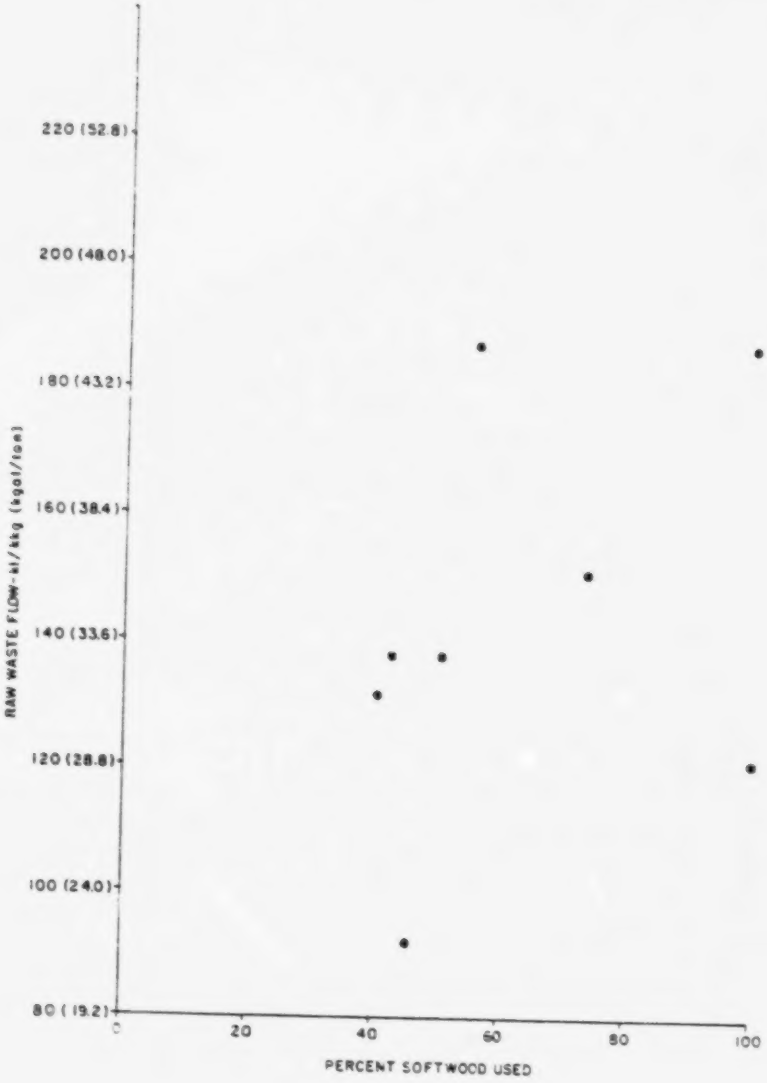
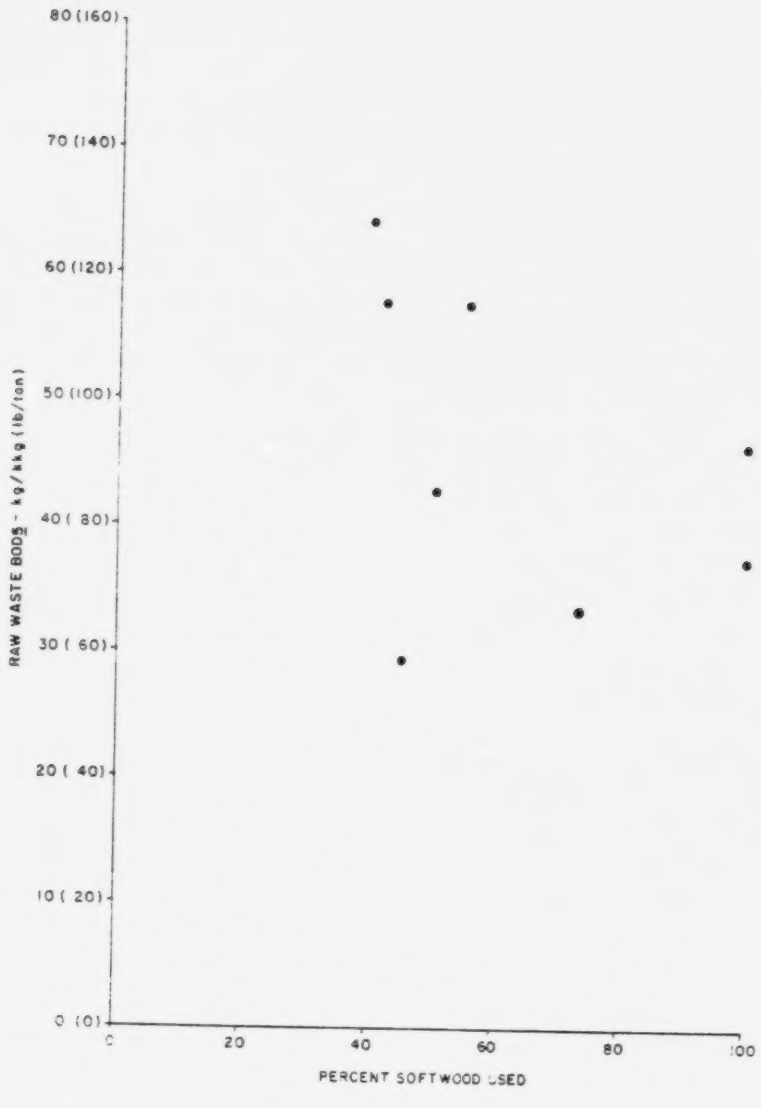


FIGURE V-8
RAW WASTE BOD5 VERSUS PERCENT SOFTWOOD USED
BCT BLEACHED KRAFT SUBCATEGORY



Alkaline (Fine Bleached Kraft and Soda Subcategories). Table V-4 presents available data on wastewater discharge and BOD5 and TSS raw waste loads at 20 mills that are representative of the alkaline-fine mill grouping. Various grades of paper, both coated and uncoated, are produced from combinations of hardwood and softwood kraft pulps and, in some instances, on-site production of groundwood pulp. Attempts were made to determine if the amount of groundwood production or the extent of high use of filler and coating applications affects raw waste characteristics.

Figures V-9 and V-10 present plots of the raw waste flow and BOD5 versus the percentage of softwood pulped relative to the total product manufactured. Those mills where paper is produced using some groundwood pulp produced on-site and those where large amounts of clay are used as a filler are also shown. No relationship between raw waste flow or BOD5 and percentage of softwood pulp used is apparent. Additionally, no relationship is apparent between groundwood or high clay filler use and flow or BOD5.

Figures V-11 and V-12 present plots of raw waste flow and BOD5 versus the percentage of pulp manufactured on-site relative to the total product manufactured. No significant statistical correlation could be ascertained. Two of the mills where some groundwood pulp is produced exhibit high BOD5 raw waste load; however, the other mills where groundwood pulp is produced exhibit BOD5 raw waste loads in the same general range as for other alkaline-fine mills.

Unbleached Kraft. Table V-5 presents available data on wastewater discharge and raw waste loadings of BOD5 and TSS at mills representative of the unbleached kraft subcategory. Figures V-13 and V-14 are presented to illustrate the effect of product type on raw waste loads. Based on this analysis, the subcategory has been divided into two separate groups: unbleached kraft (linerboard) and unbleached kraft (bag and other products). As shown on Table V-5 and Figures V-13 and V-14, significantly different wastewater discharge exists for the two groups. The bag and other product mills generally have higher flow, BOD5, and TSS raw waste loads.

Semi-Chemical. Table V-6 presents available raw wastewater data for each of the 19 mills where a semi-chemical pulping process is employed. Corrugating medium is the primary product of these mills; various chemical processes, chemical bases, and liquor recovery systems are utilized at mills in this subcategory. Previously, sodium-based and ammonia-based neutral sulfite semi-chemical (NSSC) processes were identified. Ammonia-based cooking liquors are now used at only one mill. The raw waste loads for the ammonia-based mill are not substantially different from the other semi-chemical mills: flow and TSS raw waste loads are well below the subcategory average; BOD5 is above the subcategory average but is not the highest in the subcategory.

Many process innovations are being applied at mills in this subcategory including the use of no-sulfur pulping and green liquor

TABLE V-4

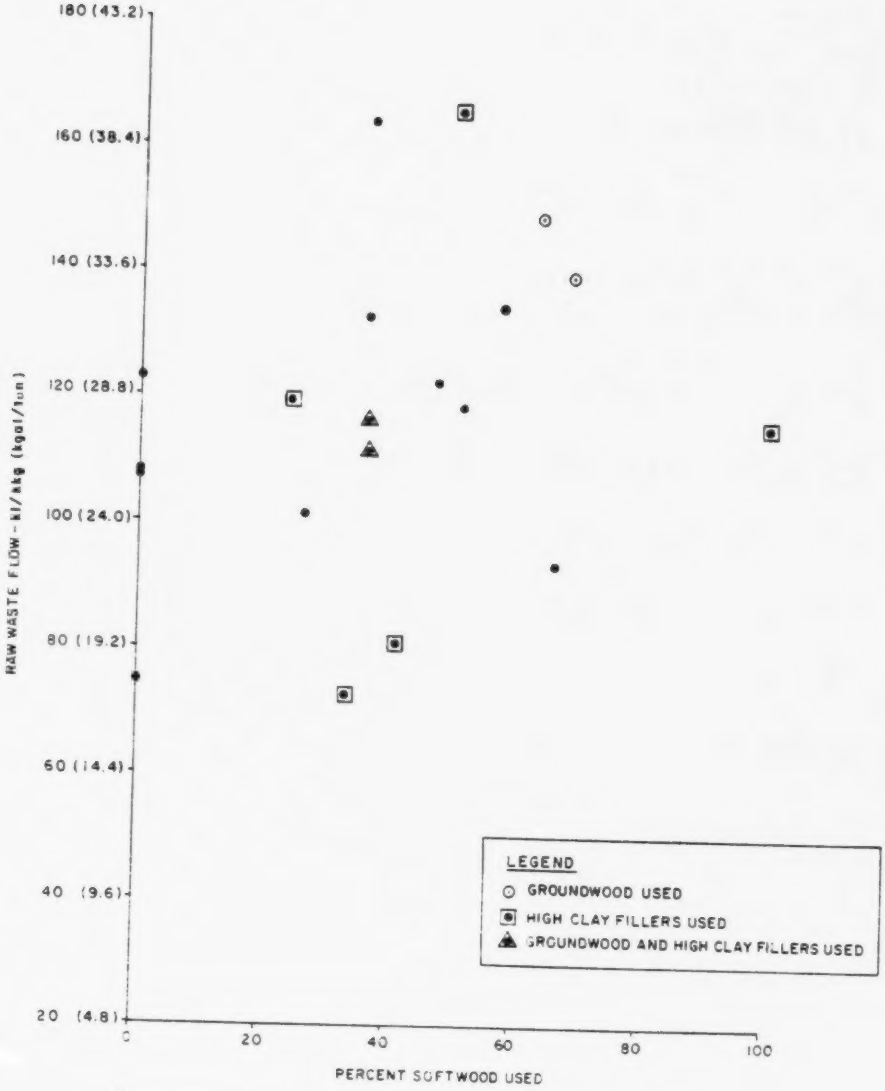
SUMMARY RAW WASTE LOAD DATA
ALKALINE-FINE*

Mill No.	Production Profile Pulp (t/d) HW	SW	Purch Pulp	(t/d) Broke(a)	Product (t/d) Ctd	Unctd	Other	Total	Raw Waste Load Flow kl/kkg	(kgal/t)	BOD5 kg/kkg	(lb/t)	TSS kg/kkg	(lb/t)	≤BPT(b)
030001	101	35	23	10	--	--	191	191	101.8	(24.4)	22.7	(45.4)	46.8	(93.5)	BF
030013	146	129	25	154	68	120	322	510	122.7	(29.4)	--	(--)	--	(--)	F
030015(c)	124	123	11	45	370	--	--	370	165.7	(39.7)	51.0	(101.9)	80.0	(160.0)	
030020(c)	--	174	118	27	--	--	417	417	116.0	(27.8)	25.5	(51.0)	78.5	(157.0)	BF
030027(c)	292	199	18	78	27	310	345	682	81.0	(19.4)	24.1	(48.2)	36.9	(73.8)	BF
030034(c)	341	109	90	--	--	--	708	708	119.3	(28.6)	--	(--)	--	(--)	F
030037	449	476	60	102	--	114	914	1,028	118.5	(28.4)	--	(--)	--	(--)	F
030046	408	232	4	--	348	342	50	740	132.7	(31.8)	31.2	(62.3)	80.4	(160.8)	B
030049(c)	449	224	9	33	1,137	41	--	1,178	72.6	(17.4)	21.6	(43.1)	55.0	(109.9)	BF
030051	113	218	194	--	--	--	612	612	93.9	(22.5)	32.7	(65.3)	40.9	(81.7)	BF
030052	237	311	--	72	--	600	87	687	133.5	(32.0)	--	(--)	--	(--)	
030057	181	--	132	--	--	378	--	378	106.8	(25.6)	39.9	(79.8)	79.3	(158.5)	F
030059	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	122.7	(29.4)	39.1	(78.1)	147.5	(295.0)	F
030060	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	163.6	(39.2)	39.2	(78.4)	101.7	(203.3)	
130001	535	--	129	70	--	458	233	691	74.3	(17.8)	39.8	(79.5)	23.7	(47.4)	F
130002	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	107.7	(25.8)	23.5	(47.0)	115.2	(230.3)	BF
Average (Mills w/o GWD)									114.8	(27.5)	32.5	(65.0)	73.8	(147.6)	
030033(e)	216	464	28	--	412	242	184	838	139.4	(33.4)	75.4	(150.7)	--	(--)	
030045(c)	270	460	55	139	524	51	388	963	148.6	(35.6)	65.2	(130.4)	126.2	(252.3)	
030048(c)(e)	431	240	11	10	527	411	18	956	111.4	(26.7)	31.5	(63.0)	89.8	(179.6)	BF
030058(a)(c)(e)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	(d)	115.6	(27.7)	31.0	(62.0)	78.9	(157.8)	BF
Average (Mills w/GWD)									128.9	(30.9)	50.8	(101.5)	98.3	(196.6)	
Overall Average									117.3	(28.1)	37.1	(74.1)	78.7	(157.4)	
Average High Clay Mills									111.8	(26.8)	30.8	(61.5)	69.9	(139.7)	
BPT Raw Waste Load									129.0	(30.9)	33.6	(67.2)	75.0	(150.0)	
Average of Mills with ≤BPT flow									104.7	(25.1)	30.1	(60.2)	72.0	(144.0)	
Average of Mills with ≤BPT BOD5									103.5	(24.8)	27.1	(54.1)	69.2	(138.3)	

(a)May include some in-mill broke.
(b)F - Mill with ≤BPT flow; B - Mill with ≤BPT BOD5.
(c)High clay mills.
(d)Production data held confidential.
(e)Includes groundwood production.

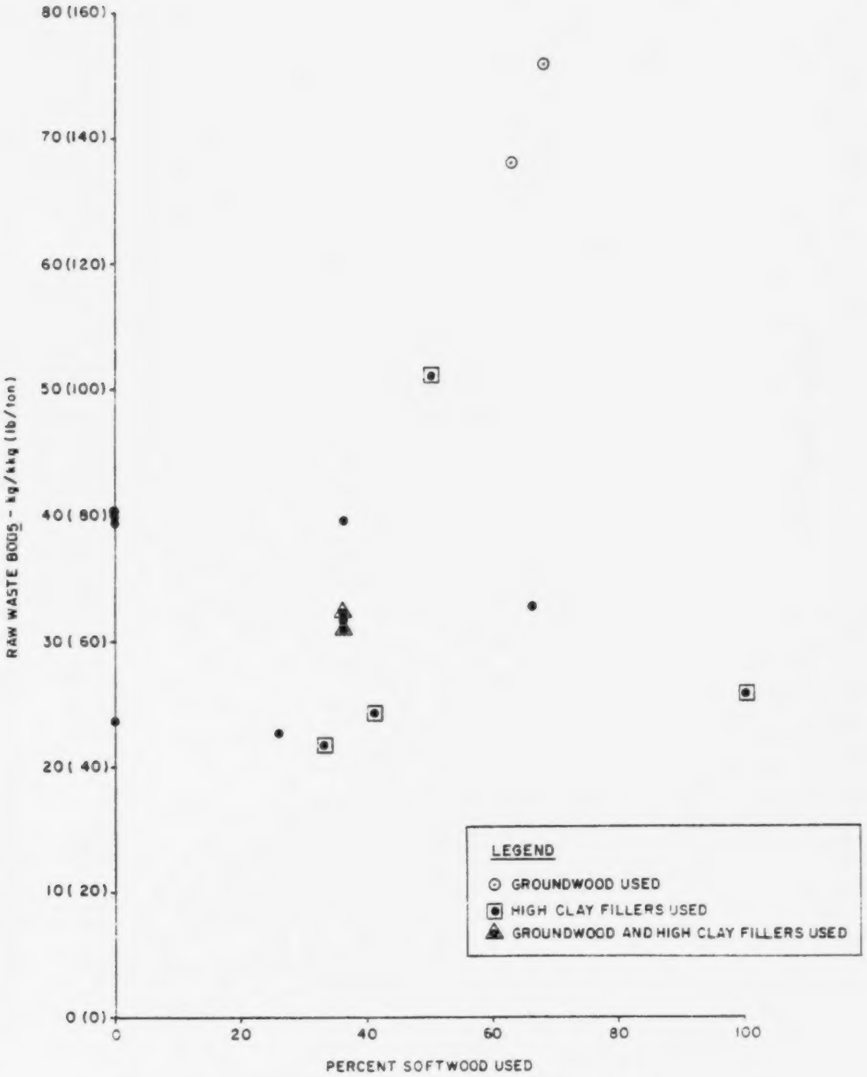
*Includes Fine Bleached Kraft and Soda Subcategories.

FIGURE V-9
RAW WASTE FLOW VERSUS PERCENT SOFTWOOD USED
ALKALINE-FINE (1)



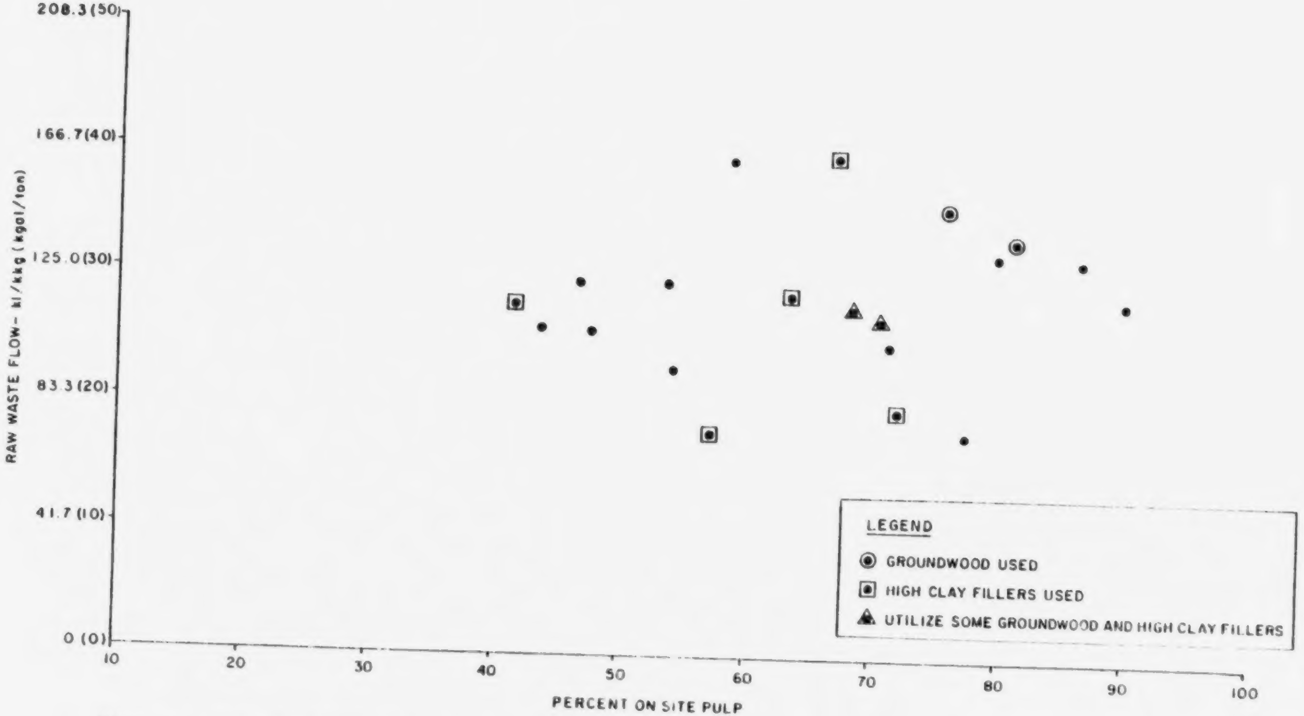
(1) INCLUDES FINE BLEACHED KRAFT AND SODA SUBCATEGORIES

FIGURE V-10
RAW WASTE BOD$_5$ VERSUS PERCENT SOFTWOOD USED
ALKALINE-FINE[1]



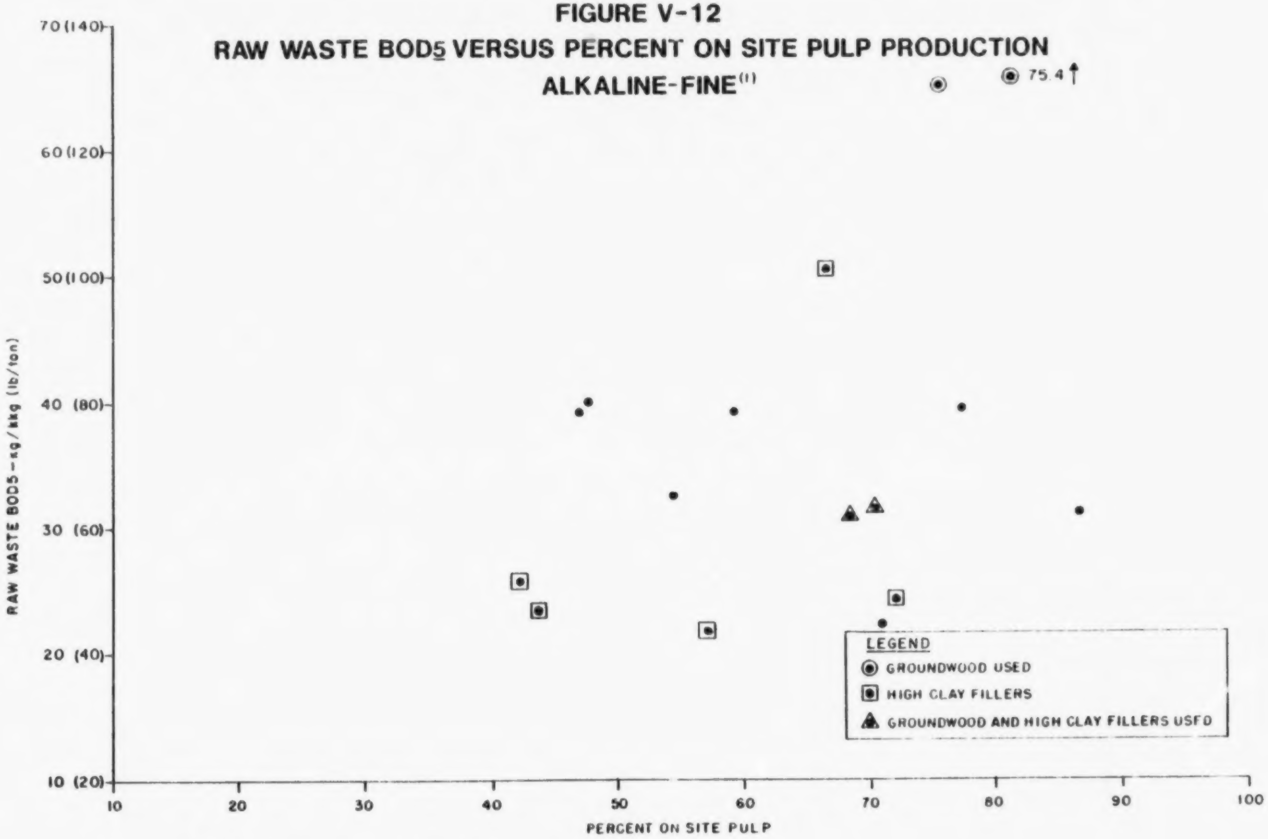
[1] INCLUDES BLEACHED KRAFT FINE AND SODA SUBCATEGORIES

FIGURE V-11
RAW WASTE FLOW VERSUS PERCENT ON SITE PULP PRODUCTION
ALKALINE-FINE[1]



[1] INCLUDES FINE BLEACHED KRAFT AND SODA SUBCATEGORIES

FIGURE V-12
RAW WASTE BOD5 VERSUS PERCENT ON SITE PULP PRODUCTION
ALKALINE-FINE(1)



(1) INCLUDES FINE BLEACHED KRAFT AND SODA SUBCATEGORIES

TABLE V-5

SUMMARY RAW WASTE LOAD DATA
UNBLEACHED KRAFT SUBCATEGORY

	Production Profile							Raw Waste Load						
	Furnish(t/d)			Product (t/d)				Flow		BOD5		TSS		
Mill No.	Kraft	WP	Purch Broke	Linerboard	Bag	Other	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≤BPT(b)
Linerboard														
010001	450	--	20	450	--	--	450	46.3	(11.1)	8.3	(16.5)	26.9	(53.7)	BF
010002	923	--	--	934	--	--	934	44.2	(10.6)	14.1	(28.2)	24.7	(49.4)	BF
010018	1,170	30	--	1,081	--	--	1,081	44.2	(10.6)	18.1	(36.1)	14.1	(28.2)	F
010019	1,127	39	27	1,144	--	7	1,151	35.1	(8.4)	9.6	(19.1)	4.8	(9.6)	BF
010020	971	55	61	965	--	44	1,009	81.0	(19.4)	20.5	(41.0)	27.6	(55.1)	
010025	523	39	--	563	--	4	567	44.7	(10.7)	13.9	(27.8)	9.8	(19.6)	BF
010032	(a)	(a)	(a)	(a)	(a)	(a)	(a)	47.2	(11.3)	18.3	(36.5)	17.4	(34.8)	F
010033	(a)	(a)	(a)	(a)	(a)	(a)	(a)	--	(--)	--	(--)	--	(--)	
010038	750	68	5	789	--	--	789	105.2	(25.2)	16.5	(32.9)	15.9	(31.7)	B
010040	1,195	85	--	1,220	--	--	1,220	65.1	(15.6)	14.7	(29.4)	11.4	(22.7)	B
010042	965	--	--	965	--	--	965	23.0	(5.5)	11.1	(22.2)	5.7	(11.3)	BF
010043	1,539	10	--	1,549	--	--	1,549	44.2	(10.6)	21.7	(43.4)	13.9	(27.7)	F
010046	1,176	--	27	1,102	--	21	1,123	49.2	(11.8)	14.4	(28.7)	20.1	(40.2)	BF
010047	1,299	--	--	1,194	--	--	1,194	26.3	(6.3)	6.7	(13.4)	10.8	(21.5)	BF
010057	540	--	85	620	--	--	620	38.4	(9.2)	--	(--)	--	(--)	F
010063	(a)	(a)	(a)	(a)	(a)	(a)	(a)	31.7	(7.6)	46.3	(92.6)	9.9	(19.8)	F
010064	664	51	--	666	--	--	666	34.2	(8.2)	14.8	(29.6)	24.3	(48.6)	BF
Average								47.6	(11.4)	16.6	(33.2)	15.8	(31.6)	
BPT Raw Waste Load								52.5	(12.6)	16.9	(33.8)	21.9	(43.8)	
Average of Mills with ≤BPT flow								39.2	(9.4)	16.4	(32.8)	15.2	(30.4)	
Average of Mills with ≤BPT BOD5								47.2	(11.3)	12.4	(24.8)	15.4	(30.8)	
Bag and Other Products														
010003	243	12	--	--	283	--	283	42.1	(10.1)	--	(--)	--	(--)	F
010005	1,286	--	8	898	332	--	1,230	66.4	(15.9)	20.3	(40.6)	20.5	(40.9)	B
010006	1,685	--	51	1,115	478	--	1,594	52.6	(12.6)	12.5	(25.0)	--	(--)	BF
010008	1,895	--	--	1,540	434	--	1,974	73.9	(17.7)	18.8	(37.6)	45.7	(91.3)	B
010028	400	10	--	25	279	95	399	110.2	(26.4)	--	(--)	13.3	(26.6)	
010044	1,020	--	82	362	712	--	1,074	57.2	(13.7)	12.5	(24.9)	17.8	(35.6)	B
010055	748	2	12	--	726	--	726	58.4	(14.0)	30.5	(60.9)	23.2	(46.4)	
010060(c)	470	--	25	--	443	--	443	85.1	(20.4)	--	(--)	--	(--)	
010062	231	--	10	--	234	--	234	151.5	(36.3)	20.6	(41.1)	8.6	(17.2)	B
010034	940	--	48	404	453	68	925	94.7	(22.7)	36.8	(73.5)	24.3	(48.6)	
010035	(a)	(a)	(a)	(a)	(a)	(a)		227.8	(54.6)	34.2	(68.4)	56.3	(112.6)	
010048	(a)	(a)	(a)	(a)	(a)	(a)		223.3	(53.5)	32.9	(65.7)	73.2	(146.3)	
Average								103.5	(24.8)	24.3	(48.6)	31.4	(62.8)	
BPT Raw Waste Load								52.5	(12.6)	16.9	(33.8)	21.9	(43.8)	
Assumed BPT Raw Waste Load								52.5	(12.6)	24.3	(48.6)	21.9	(43.8)	
Average of Mills with ≤BPT flow								47.6	(11.4)	12.5	(25.0)	--	(--)	
Average of Mills with ≤ Assumed BPT BOD5								80.1	(19.2)	16.9	(33.8)	23.2	(46.3)	

(a)Production data held confidential.
(b)F - Mill with ≤BPT flow; B - Mill with ≤ Assumed BPT BOD5.
(c)Mill now closed.

FIGURE V-13
RAW WASTE FLOW VERSUS PRODUCTION
UNBLEACHED KRAFT SUBCATEGORY

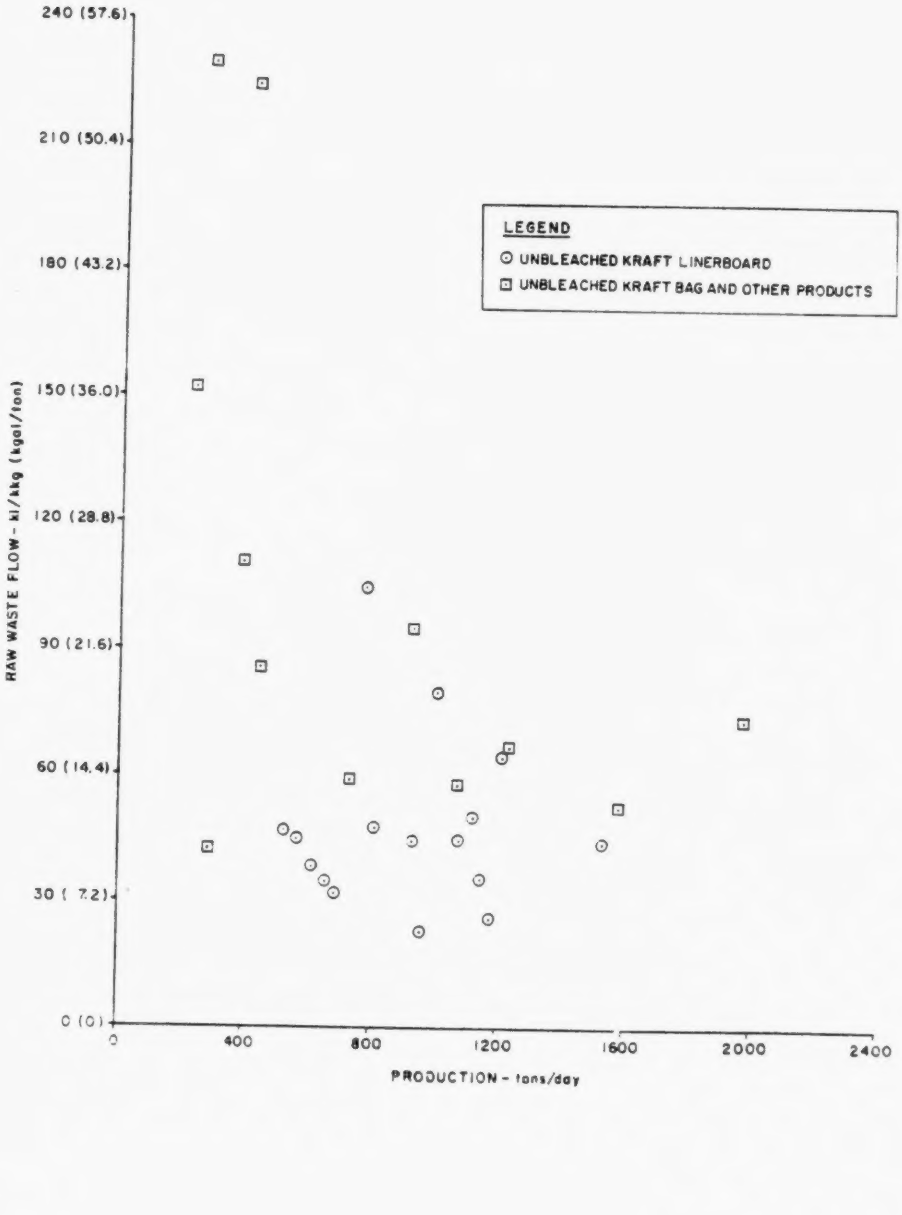


FIGURE V-14

RAW WASTE BOD$_5$ VERSUS PRODUCTION
UNBLEACHED KRAFT SUBCATEGORY

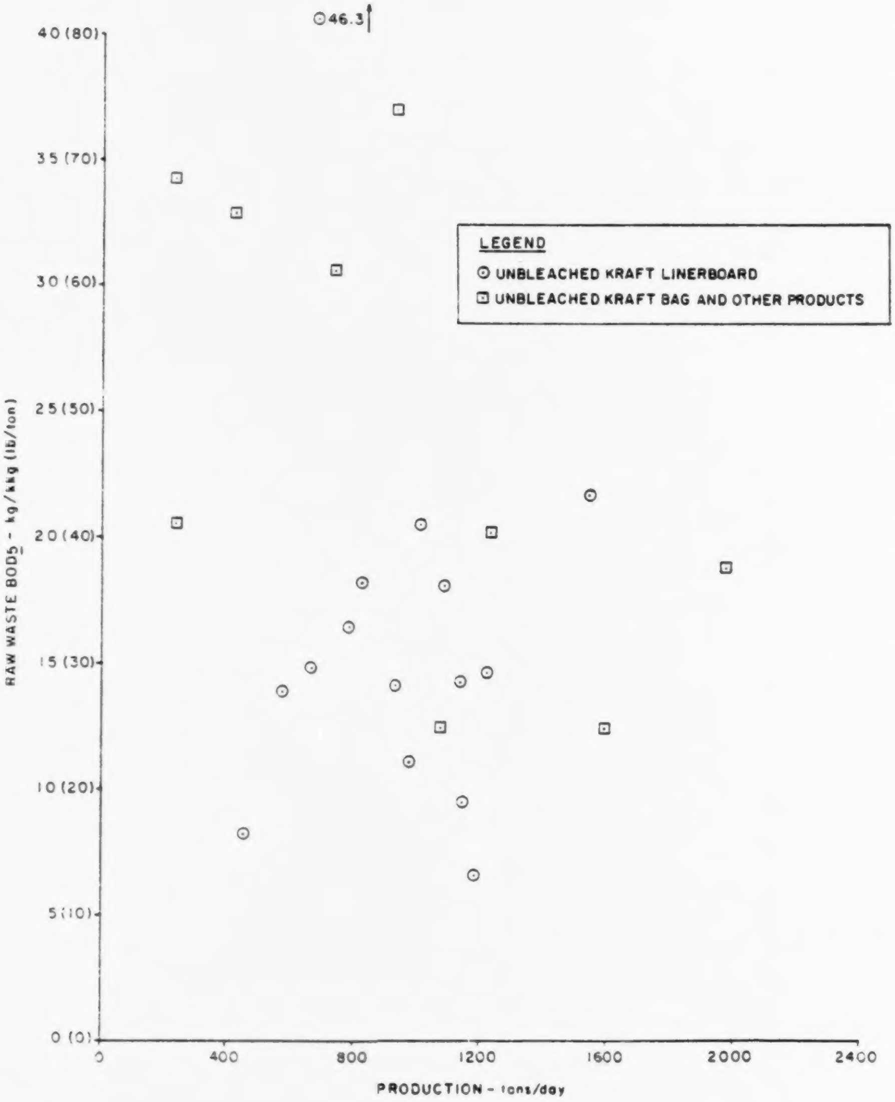


TABLE V-6

SUMMARY RAW WASTE LOAD DATA
SEMI-CHEMICAL SUBCATEGORY

	Production Profile				Raw Waste Load						
	Furnish (t/d)			Product	Flow		BOD5		TSS		
Mill No.	Semi-Chem	WP	Broke	(t/d)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≤BPT(a)
I. Mills With Liquor Recovery and Less Than 1/3 WP											
020002	248	90	20	331	24.2	(5.8)	12.9	(25.7)	30.2	(60.4)	BF
020003(b)	582	61	--	618	40.1	(9.6)	25.3	(50.5)	13.2	(26.3)	F
020008(b)	231	125	--	318	23.0	(5.5)	9.6	(19.2)	6.9	(13.7)	BF
020009(b)	(c)	(c)	(c)	(c)	28.8	(6.9)	14.4	(28.8)	17.8	(35.6)	BF
020010	(c)	(c)	(c)	(c)	60.5	(14.5)	17.9	(35.7)	49.3	(98.5)	B
020013	472	173	--	599	39.6	(9.5)	39.0	(77.9)	37.8	(75.5)	F
020014(d)	394	117	--	511	26.7	(6.4)	31.2	(62.3)	18.8	(37.6)	F
020017	(c)	(c)	(c)	(c)	30.5	(7.3)	20.7	(41.3)	44.5	(89.0)	BF
060004(b)	385	98	9	492	48.8	(11.7)	27.8	(55.6)	54.6	(109.2)	
Average					35.9	(8.6)	22.1	(44.1)	30.3	(60.6)	
BPT Raw Waste Load					42.9	(10.3)	25.2	(50.4)	12.3	(24.6)	
Average of Mills with ≤BPT flow					30.5	(7.3)	21.9	(43.7)	24.2	(48.3)	
Average of Mills with ≤BPT BOD5					33.4	(8.0)	15.1	(30.1)	29.7	(59.4)	
II. Mills With Liquor Recovery and More Than 1/3 WP											
020001	204	116	--	302	19.2	(4.6)	23.6	(47.1)	8.1	(16.1)	BF
020004(e)	160	106	--	266	25.0	(6.0)	1.3	(2.6)	0.2	(0.3)	
020006	190	99	--	291	16.3	(3.9)	24.2	(48.4)	--	(--)	BF
020007	183	123	--	346	10.4	(2.5)	--	(--)	--	(--)	F
020011(f)	235	157	--	377	34.2	(8.2)	22.6	(45.2)	6.0	(11.9)	
020012	(c)	(c)	(c)	(c)	28.4	(6.8)	--	(--)	--	(--)	F
Average					18.8	(4.5)	23.9	(47.8)	8.1	(16.1)	
BPT Raw Waste Load					42.9	(10.3)	25.2	(50.4)	12.3	(24.6)	
Average of Mills with ≤BPT flow					18.8	(4.5)	23.9	(47.8)	8.1	(16.1)	
Average of Mills with ≤BPT BOD5					17.9	(4.3)	23.9	(47.8)	8.1	(16.1)	
III. Mills Without Liquor Recovery											
020005	137	46	--	183	47.2	(11.3)	56.1	(112.1)	52.4	(104.7)	
020015	118	50	--	169	20.4	(4.9)	33.2	(66.4)	27.9	(55.7)	F
Average					33.8	(8.1)	44.7	(89.3)	40.1	(80.2)	
IV. Non Representative Mills											
020018(g)	217	450	--	673	30.5	(7.3)	62.8	(125.6)	61.5	(123.0)	F
020016(g)	200	221	--	525	55.5	(13.3)	50.5	(100.9)	42.2	(84.3)	
Average					43.0	(10.3)	56.7	(113.3)	51.9	(103.7)	
Average of All Mills					30.9	(7.4)	25.8	(51.6)	30.1	(60.2)	
BPT Raw Waste Load					42.9	(10.3)	25.2	(50.4)	12.3	(24.6)	
Average of Mills with ≤BPT flow (Group I and II)					26.3	(6.3)	22.3	(44.6)	22.2	(44.3)	
Average of Mills with ≤BPT BOD5 (Group I and II)					28.8	(6.9)	17.6	(35.2)	26.1	(52.2)	

(a) F - Mill with ≤BPT flow; B - Mill with ≤BPT BOD5.
(b) No-sulfur pulping.
(c) Production data held confidential.
(d) Ammonia-base.
(e) A reverse osmosis system is used to treat internal process streams and allow for extensive recycle of these treated streams. Not included in averages.
(f) Mill 020011 has combined effluent with other mills. Not included in averages.
(g) Mill 020018 makes recycled paperboard and corrugating. Mill 020016 makes tissue and fine papers. These mills are not considered representative and are not included in averages.

pulping to displace the conventional NSSC cook. Insignificant differences exist in raw waste loadings at the no-sulphur mills compared to mills where the conventional NSSC process is employed. Similar results would be anticipated if data were available on green liquor pulping.

Incomplete on-site chemical recovery existed at two mills at the time of data acquisition. As expected, these mills exhibit significantly higher BOD5 raw waste loads than the other mills in this subcategory. Two additional mills are not included in averages of data presented in Table V-6 because they are not representative of general practices of the semi-chemical subcategory. At one, a variety of recycled paperboard grades as well as corrugating media are produced; at the other, tissue and fine papers are made as well as semi-chemical corrugating media.

Data for another mill (020004) are not included in averages presented in Table V-6. At this mill, a reverse osmosis system is utilized to treat some process wastewater and provide for extensive internal recycle, thus substantially reducing raw waste loads. This reliance on extensive production process controls is not typical of the approach taken at most other mills in this subcategory.

Utilization of wastepaper in the furnish at mills in the semi-chemical subcategory ranges from about 10 percent to 67 percent of total production. Therefore, the effect of wastepaper usage on raw waste load flow and BOD5 has been evaluated to determine if the percentage of wastepaper used affects raw waste load.

Figures V-15 and V-16 present plots of raw waste flow and BOD5 versus the percentage of wastepaper used in the furnish relative to the total product. Flow tends to decrease with an increase in the percentage of wastepaper used. However, a significant statistical correlation could not be determined. No significant relationship exists between BOD5 raw waste load and the percentage of wastepaper used.

Unbleached Kraft and Semi-Chemical. The ten mills for which data are available that are representative of the unbleached kraft and semi-chemical subcategory are some of the largest mills in the industry with an average production of approximately 1,360 metric tons/day (1,500 tons/ day). Table V-7 presents available raw waste load data for this subcategory. At all of these facilities, unbleached kraft pulps are produced along with high yield unbleached semi-chemical pulps. These products are commonly utilized in the manufacture of linerboard and corrugating media. At some mills, other types of kraft paper including board, bag, and converting papers are also made on-site. Table V-7 also shows the percentage of each product made at each mill along with the percentage of unbleached kraft and semi-chemical pulp produced. Kraft pulp production averages about five times as much as semi-chemical pulp production. This reflects a typical balanced cross-recovery system with fresh liquor makeup to the semi-chemical process to counterbalance chemical losses from that operation and the kraft pulping operation. The distribution

FIGURE V-15

RAW WASTE FLOW VERSUS PERCENT WASTEPAPER USED SEMI-CHEMICAL SUBCATEGORY

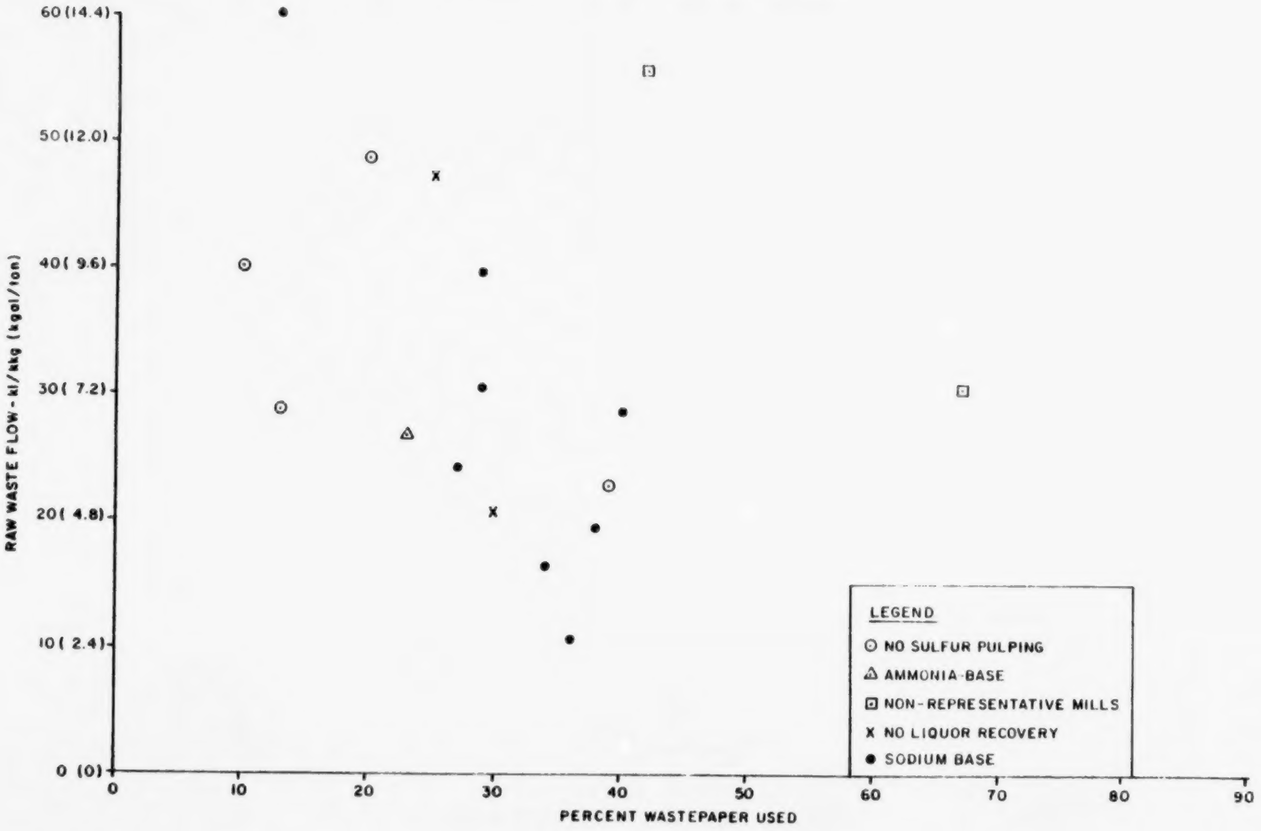


FIGURE V-16
RAW WASTE BOD$_5$ VERSUS PERCENT WASTEPAPER USED
SEMI-CHEMICAL SUBCATEGORY

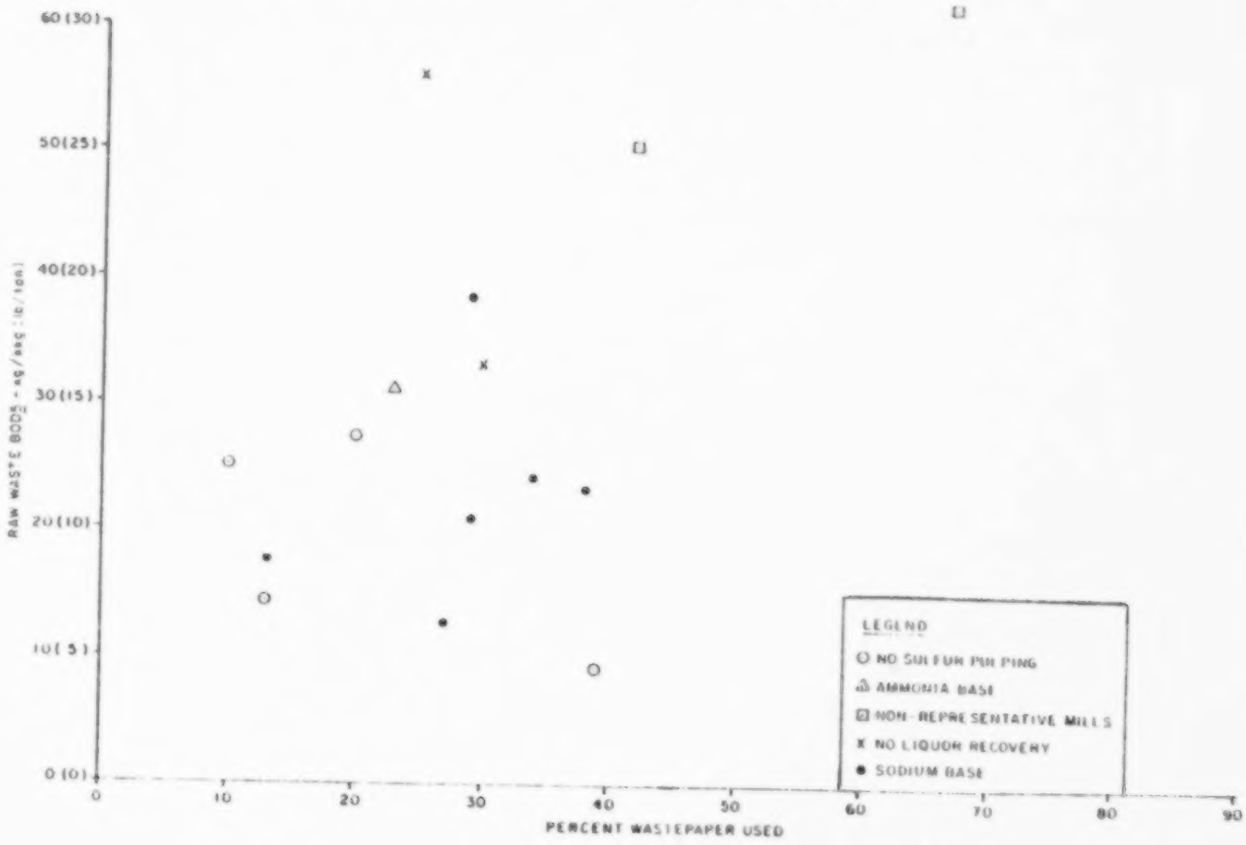


TABLE V-7

SUMMARY RAW WASTE LOAD DATA
UNBLEACHED KRAFT AND SEMI-CHEMICAL SUBCATEGORY

	Production Profile						Raw Waste Load						
	Furnish(%)(a)		Product				Flow		BOD5		TSS		
Mill No.	Semi-Chem	UBK	Corrugating(%)	Board (%)	Bag(%)	Total(t/d)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≤BPT(b)
015001(c)(d)	17	86	21	74	5	1,745	58.4	(14.0)	23.6	(47.2)	27.5	(55.0)	F
015002	20	67	24	60	17	(e)	47.2	(11.3)	13.5	(27.0)	13.5	(27.0)	BF
015003	16	85	20	80	0	(e)	50.9	(12.2)	18.8	(37.6)	29.0	(58.0)	BF
015004(d)	16	77	18	70	12	(e)	67.6	(16.2)	17.1	(34.2)	47.0	(94.0)	B
015005(c)(d)	16	84	21	0	79	1,394	30.5	(7.3)	8.8	(17.6)	--	(--)	BF
015006(c)(d)	9	90	12	50	38	2,598	50.5	(12.1)	18.9	(37.8)	9.8	(19.6)	BF
015007(c)(d)	14	76	21	79	0	1,700	52.2	(12.5)	16.3	(32.6)	25.1	(50.2)	BF
015008(c)	18	84	16	84	0	1,133	81.0	(19.4)	19.0	(38.0)	20.7	(41.4)	B
015009(c)(f)	28	65	38	62	0	716	57.6	(13.8)	28.1	(56.2)	29.1	(58.2)	F
010017(d)	13	91	16	58	26	1,428	36.7	(8.8)	17.5	(35.0)	38.3	(76.6)	BF
Average							53.4	(12.8)	18.2	(36.3)	26.7	(53.3)	
Average for mills with >20% bag production							39.2	(9.4)	15.1	(30.1)	24.1	(48.1)	
Average for mills using varying amounts of green liquor for pulping							49.2	(11.8)	17.1	(34.1)	29.6	(59.1)	
BPT Raw Waste Load							58.4	(14.0)	19.4	(38.8)	20.5	(41.0)	
Average of Mills with ≤BPT flow							48.0	(11.5)	18.2	(36.4)	24.6	(49.2)	
Average of Mills with ≤BPT BOD5							52.2	(12.5)	16.3	(32.5)	26.2	(52.4)	

(a) Calculated percentage based on claimed production. Other fibers and/or losses not accounted for.
(b) F - Mill with ≤BPT flow; B - Mill with ≤BPT BOD5.
(c) Market pulp production is included with board production data; production of converting papers is included with bag production.
(d) Varying amounts of green liquor used for pulping.
(e) Production data held confidential.
(f) Data is representative of unbleached kraft and semi-chemical operation. Subsequent to data collection mill has converted to some bleached kraft processes and is now classified as an integrated miscellaneous mill.

of production as well as the range in the ratio of semi-chemical to kraft pulp are reasonably constant in this subcategory, except for one mill where about ten times as much kraft is produced as semi-chemical pulp.

Six mills are known to be utilizing varying amounts of green liquor for pulping in the semi-chemical operation. This is done to enable an increase in semi-chemical pulp production relative to unbleached kraft production and/or to facilitate the recovery of chemical cooking liquor. No trends are apparent with respect to raw waste loads relative to either alterations of the semi-chemical process or to variations in the products manufactured.

Because the production of bag papers in the unbleached kraft subcategory has a significant effect on raw waste load, an investigation was made of those unbleached kraft and semi-chemical mills where higher percentages of bag papers are produced. As shown in Table V-7, the average raw waste loadings for the three mills where greater than 20 percent of the final product is bag paper are lower than the overall subcategory averages. In fact, the mill (015005) where the highest percentage of bag paper is produced has the lowest raw waste load flow and BOD$\underline{5}$ in the subcategory.

Dissolving Sulfite Pulp. Table V-8 presents available data on wastewater discharge and raw waste loadings of BOD$\underline{5}$ and TSS at mills representative of the dissolving sulfite pulp subcategory. At the six mills where dissolving grade sulfite pulps are produced, the capability exists for also producing papergrade pulps. Predominantly softwoods are utilized with only small amounts of hardwood associated with the production of dissolving grades of sulfite pulp. Both magnesium and ammonia-based pulping operations are employed. In order to facilitate the production of the high purity pulps required, extensive washing and evaporation systems are used and often entail two evaporator lines operating in series. Extensive bleaching operations, frequently with six or more stages, are used to purify the cellulose. Consequently, large amounts of dissolved solids (including BOD$\underline{5}$) are discharged from the bleaching operations as well as with spent sulfite pulping liquors. Extensive use is made of jumpstage countercurrent washing systems to minimize wastewater discharge. At two mills, a system is used which enables the evaporation of the total effluent from the caustic extraction stage, which has the highest BOD$\underline{5}$ loading discharged from the bleaching operation.

BPT effluent limitations are based on the grade of pulp produced, including nitration, viscose, cellophane, and acetate grades. Data gathered since the BPT program have been evaluated to verify the need for effluent limitations by grade. However, insufficient data are available to allow for presentation of raw waste load data by grade. Complete data are lacking for half the mills.

Papergrade Sulfite (Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories). Table V-9 presents available raw waste load data for 17 mills characteristic of these subcategories.

TABLE V-8

SUMMARY RAW WASTE LOAD DATA
DISSOLVING SULFITE PULP SUBCATEGORY

		Raw Waste Load					
	Production	Flow		BOD5		TSS	
Mill No.	(t/d)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
046001(a)	421	228.7	(54.8)	154.1	(308.2)	29.3	(58.6)
046002(b)	560	259.1	(62.1)(c)	--	(--)	--	(--)
046003	620	265.0	(63.5)(c)(d)	114.5	(228.9)	11.2	(22.3)
046004(f)	(e)	190.7	(45.7)	97.2	(194.4)	39.6	(79.2)
046005	(e)	358.5	(85.9)	276.0	(552.0)	--	--
046006(a)	(e)	182.8	(43.8)	99.2	(198.3)	53.6	(107.1)
Average		258.7	(62.0)	161.0	(321.9)	31.3	(62.7)
BPT Raw Waste Loads are dependent on processes used and are as follows:							
Nitration		275.0	(66.0)	137.0	(274.0)	92.5	(185.0)
Viscose		275.0	(66.0)	156.0	(312.0)	92.5	(185.0)
Cellophane		275.0	(66.0)	181.5	(363.0)	92.5	(185.0)
Acetate		303.4	(72.7)(g)	266.0	(531.9)(g)	92.5	(185.0)

(a) Data obtained from responses by mill representatives to a 1981 questionnaire.

(b) Total raw waste BOD5 and TSS data are not available.

(c) Flow data obtained from telephone conversations with mill representatives in 1981.

(d) Flow data based on 1981 process flow and corresponding 647 ton/day production rate.

(e) Production data held confidential.

(f) Raw waste loads include wastewater from a dissolving sulfite pulp mill and a paper mill. Therefore, data were not included in the averages.

(g) The flow and BOD5 are representative of the raw waste load associated with the production of acetate grade dissolving pulp at the time the remanded BPT BOD5 limitation was promulgated in 1977.

TABLE V-9

SUMMARY RAW WASTE LOAD DATA
PAPERGRADE SULFITE SUBCATEGORY

	Production Profile						Raw Waste Load						
		% On-site Sulfite Pulp		Process			Flow		BOD5		TSS		
Mill No.	(t/d)	Produced	Type	Wash	Base	Condenser	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≧BPT(a)
040001(b)	(c)	82	Corrug	BP	NH3,BS	U	135.2	(32.4)	68.7	(137.3)	--	(--)	
040002(d)	547	101	Market Tissue	BP	Ca,Na A, BS	Ba,S	313.0	(75.0)	84.1	(168.2)	21.0	(42.0)	B
040006(e)(f)	131	89	Tissue Market	BP	NH3,A	S	346.8	(83.1)	--	(--)	--	(--)	
040007(e)(g)	135	100	Market	BP	NH3,A	None	196.1	(47.0)	421.3	(842.5)	--	(--)	
040008(d)	964	78	Tissue Market	BP/DR	NH3,A	Ba,S	186.5	(44.7)	--	(--)	--	(--)	
040009(d)	566	41	Writing Market	DR	MgO,BS	S	83.9	(20.1)	48.9	(97.7)	28.6	(57.1)	BF
040010(h)	244	32	Glassine Package	BP	Ca,A	S	290.9	(69.7)	27.9	(55.8)	51.3	(102.5)	B
040011(d)	284	39	Writing Thin	BP	Ca,A	Ba,S	97.6	(23.4)	45.0	(89.9)	25.9	(51.8)	BF
040012(d)	270	72	Writing Printing	DR	NH3,A	Vr	225.3	(54.0)	58.5	(117.0)	90.0	(180.0)	B
040013(d)	289	56	Printing	DR	MgO,BS	S	136.5	(32.7)	41.4	(82.8)	31.9	(63.7)	BF
040014(d)	146	59	Writing Laminating	BP	Ca,A	S	170.3	(40.8)	109.4	(218.7)	19.3	(38.6)	BF
040015	155	100	Market	BP/DR	Ca,BS	S	--	(--)	--	(--)	--	(--)	
040016(d)	437	61	Writing	DR	NH3,BS	S	159.4	(38.2)	109.3	(218.5)	140.2	(280.3)	F
040017(d)	412	42	Printing Market	BP	Ca,A	S	116.4	(27.9)	97.1	(194.2)	37.1	(74.1)	BF
040018(d)	359	34	Tissue	DR	Ca,A	S	131.4	(31.5)	74.2	(148.4)	65.1	(130.2)	BF
040019(i)	(c)	52	Tissue	DR	NH3,A	Vr	58.8	(14.1)	--	(--)	--	(--)	
040020(d)	671	57	Tissue	DR	NH3,A	Ba	100.6	(24.1)	36.3	(72.5)	11.9	(23.7)	BF
Average		58(j)					156.5	(37.5)	68.9	(137.7)	50.0	(99.9)	
BPT Raw Waste Load													
Blow Pit Wash													
Bisulfite-Surface							186.0	(44.5)	116.0	(232.0)	90.0	(180.0)	
Bisulfite-Barometric							221.0	(53.0)	116.0	(232.0)	90.0	(180.0)	
Acid Sulfite-Surface							186.0	(44.5)	121.0	(242.0)	90.0	(180.0)	
Acid Sulfite-Barometric							221.0	(53.0)	121.0	(242.0)	90.0	(180.0)	
Drum Wash													
Bisulfite-Surface							186.0	(44.5)	134.0	(168.0)	90.0	(180.0)	
Bisulfite-Barometric							221.0	(53.0)	134.0	(168.0)	90.0	(180.0)	
Acid Sulfite-Surface							186.0	(44.5)	103.5	(207.0)	90.0	(180.0)	
Acid Sulfite-Barometric							221.0	(53.0)	103.5	(207.0)	90.0	(180.0)	

TABLE V-9 (Continued)

Average of NH3 base acid mills	170.7	(40.9)	47.4	(94.8)	51.0	(101.9)
Average of NH3 base bisulfite mills	159.4	(38.2)	109.3	(218.5)	140.2	(280.3)
Average of MgO base bisulfite mills	110.2	(26.4)	45.2	(90.3)	30.2	(60.4)
Average of Ca base only and acid only mills	128.9	(30.9)	81.4	(162.8)	36.9	(73.7)
Average of Ca base acid mills with drum wash	131.4	(31.5)	74.2	(148.4)	65.1	(130.2)
Average of Mills with ≤BPT BOD5	152.7	(36.6)	66.1	(132.2)	36.8	(73.5)

(a) F - mill with ≤ BPT flow; B - mill with ≤BPT BOD5.

(b) Pulp was not bleached at this mill and data are therefore not included in averages. Mill is now closed.

(c) Production data held confidential.

(d) Raw waste flows from these mills were used to develop the empirical relation between raw waste flow and percent sulfite pulp produced on-site (see Figure V-19).

(e) Pulp mill operations were shut down shortly after data were gathered. This mill did not employ a recovery system. Data are not included in the averages.

(f) The pulp mill operations were shut down. Operations at this mill are now representative of the Nonintegrated-Tissue Papers subcategory.

(g) Mill is now closed.

(h) This mill produces glassine papers. Data are not included in the averages as effluent is not considered typical of the subcategory.

(i) Only a portion of raw waste load was reported. Mill data not included in averages.

(j) The average percent sulfite pulp produced on-site is based on those mills used to develop the empirical relation between flow and percent sulfite pulp (see footnote d).

At mills in these subcategories, a sulfite cooking process is employed to produce pulps from which writing, printing, business, and tissue papers are made; pulps are produced using calcium, sodium, ammonia, and magnesium cooking bases. The average quantity of papergrade sulfite pulp produced at these mills is 58 percent of the total raw material furnish.

Spent liquor recovery systems employed in this subcategory range from no recovery to the use of spent liquor evaporation systems in conjunction with modern kraft-type and fluidized bed recovery furnaces and incinerators. As shown in Table V-9, mills where recovery systems are not employed have significantly higher flow and BOD_5 raw waste loadings than mills where recovery is practiced. Two mills without recovery systems have recently been closed leaving only one mill without an adequate recovery system.

BPT effluent limitations were established for two separate papergrade sulfite subcategories: drum wash and blow pit wash. Allowances were provided for acid sulfite cooking of sulfite pulp and for mills with barometric condensers. Therefore, available raw waste load data have been reviewed with respect to the type of washing system, condenser, and cooking liquor used.

The trend in the industry has been to the use of drum washing systems. Since 1976, drum washing (vacuum washing) systems have been installed at two additional mills. Figures V-17 and V-18 present information on the effect of washing processes on raw waste load BOD_5 and flow. Raw waste flow and BOD_5 data from five papergrade sulfite mills have been excluded from the plots shown in Figures V-17 and V-18. Mill 040001 has been eliminated because pulp is not bleached at this mill. Mills 040007 and 040006 have been eliminated because recovery systems are not employed at these mills. Mill 040010 has been eliminated because of its significantly higher flow relative to other mills in the subcategory. It should be noted also that BOD_5 raw waste load at this mill is the lowest in the subcategory. Mill 040019 has been eliminated because only a portion of its raw waste load was reported. No significant difference in either the raw waste BOD_5 or flow for mills using blow pit washing compared to drum washing was found.

As illustrated in Figures V-17 and V-18, the percentage of sulfite pulp production relative to total production was determined to be a more significant factor than the type of washing system employed. Figure V-19 presents an equation, developed using a least squares fit method, that relates raw waste flow to the percentage of on-site sulfite pulp production. The correlation coefficient squared ($r^2=0.87$) reflects the good statistical correlation of the regression.

Figure V-20 presents a plot of BOD_5 raw waste load versus the percentage of sulfite pulp produced relative to total production. Information is presented on the type of chemical base and cooking process. There is no apparent correlation between BOD_5 raw waste load and the cooking process (acid or bisulfite) or cooking base (calcium, sodium, ammonia, and magnesium) used.

FIGURE V-17

EFFECT OF WASHING PROCESS ON RAW WASTE BOD_5
PAPERGRADE SULFITE SUBCATEGORY

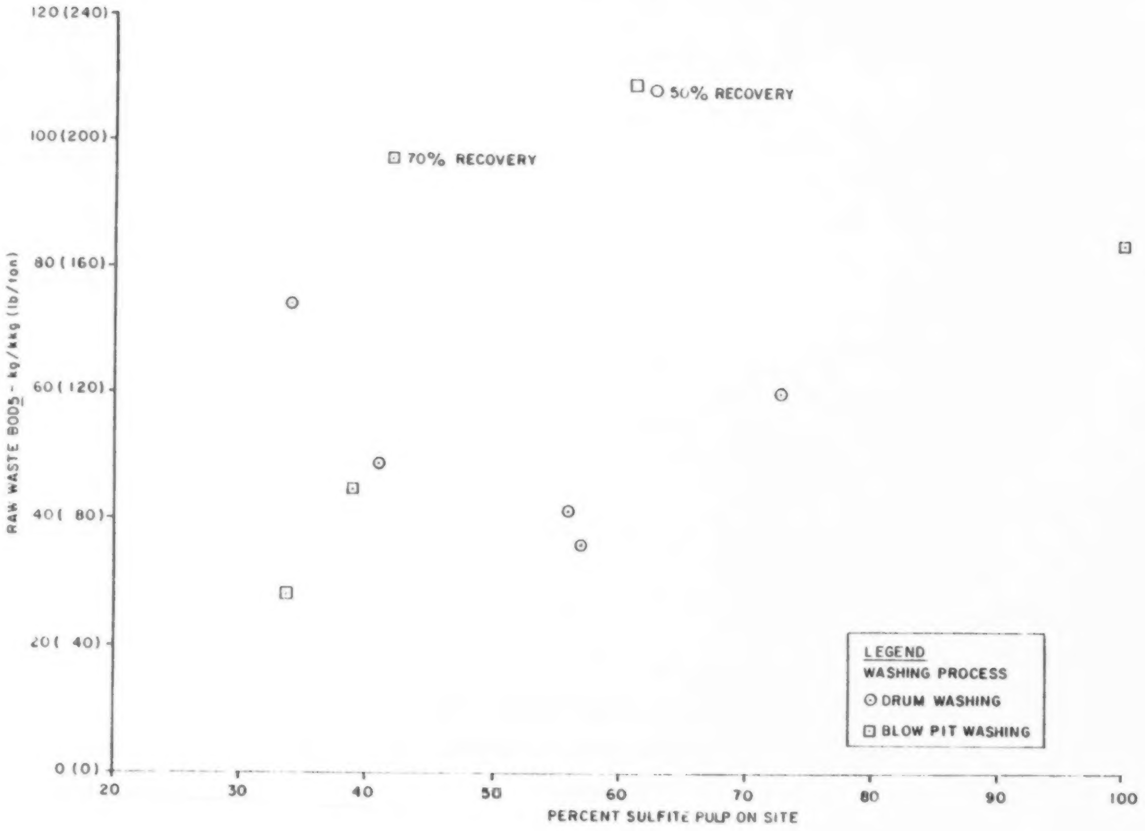


FIGURE V-18

EFFECT OF WASHING PROCESS ON RAW WASTE FLOW
PAPERGRADE SULFITE SUBCATEGORY

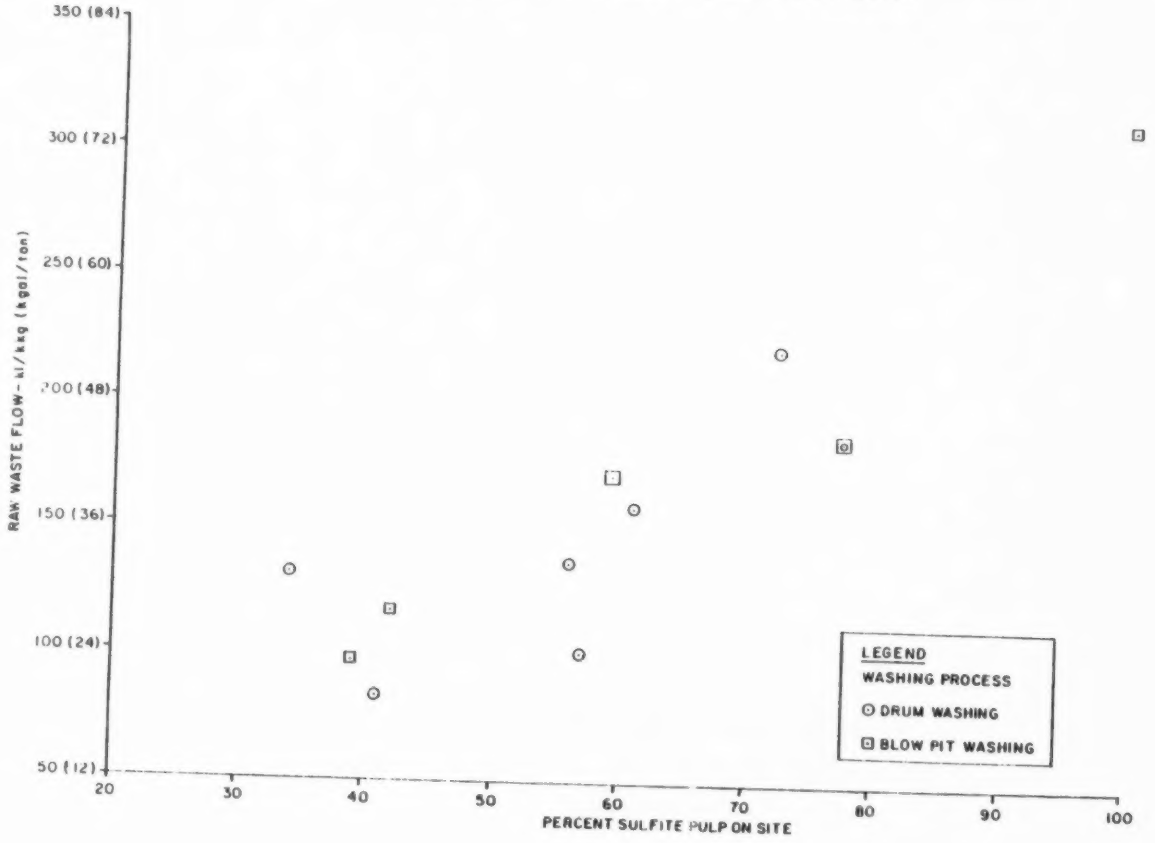


FIGURE V-19
RAW WASTE FLOW VS. PERCENT SULFITE PULP ON SITE

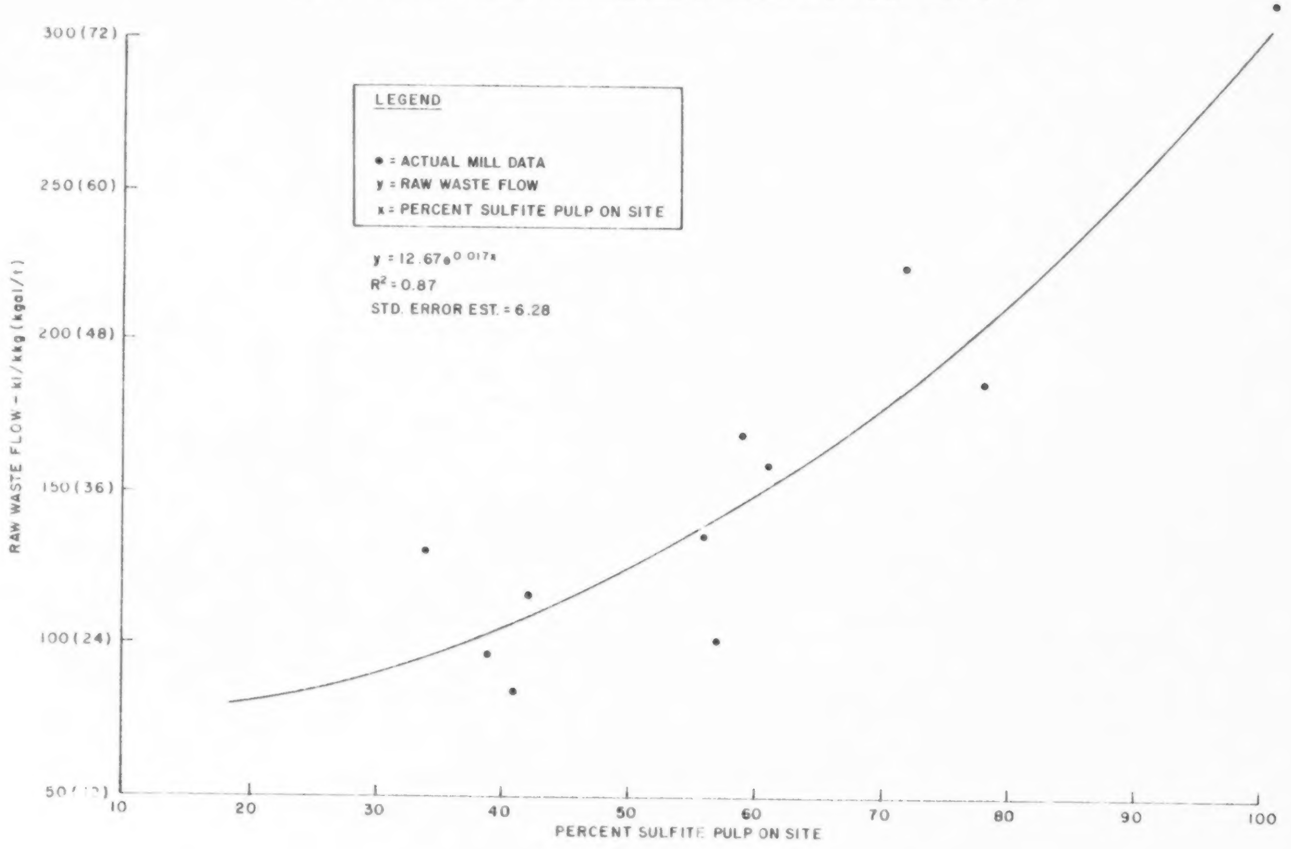


FIGURE V-20

EFFECT OF COOKING PROCESS ON RAW WASTE BOD_5 PAPERGRADE SULFITE SUBCATEGORY

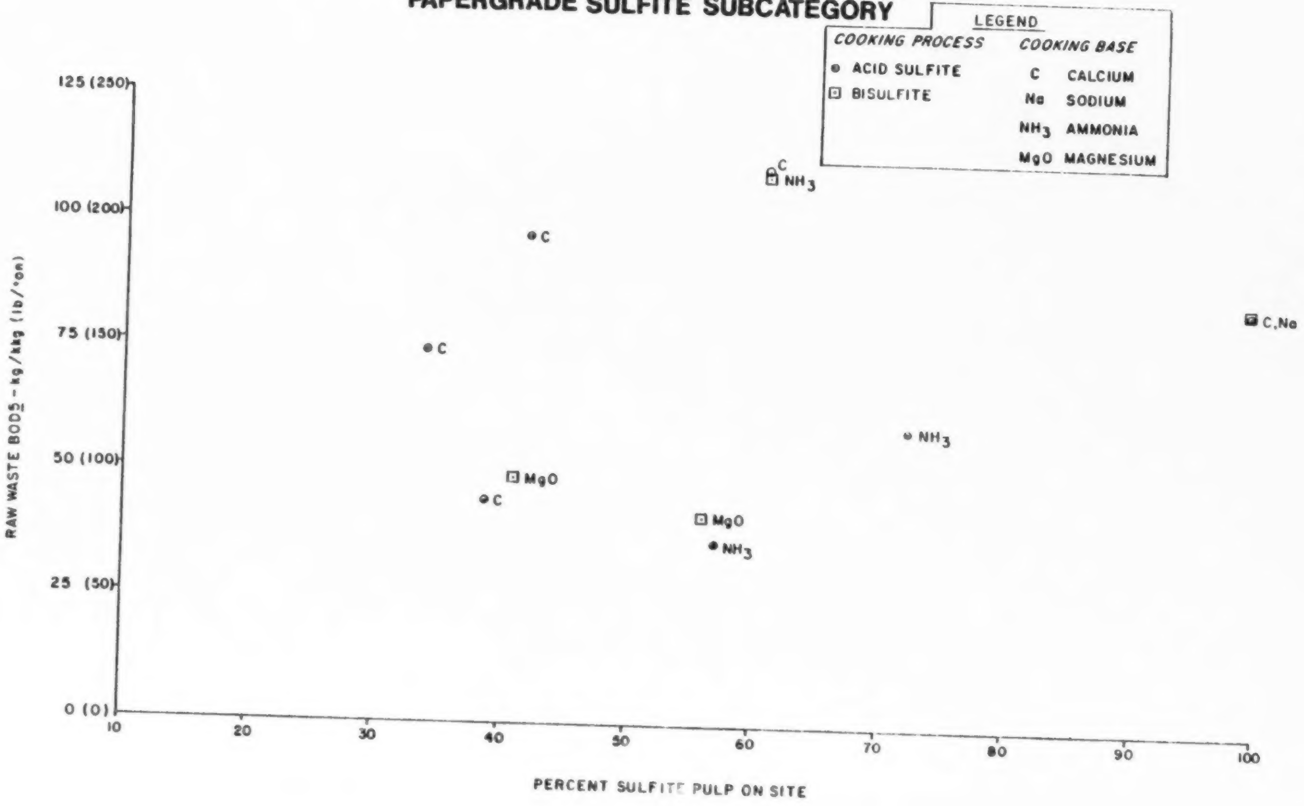


Figure V-21 presents information on the effect of condenser type on wastewater discharge. There is no apparent correlation between raw waste flow and the type of condenser used.

Groundwood-Thermo-Mechanical. Data are available for two mills that produce only groundwood-TMP pulp on-site. However, the number of TMP installations employed at complex mills in the integrated miscellaneous grouping has increased in recent years. All available data on raw waste load characteristics resulting from groundwood-thermo-mechanical pulping operations are presented in Table V-10. Included in the table are data representative of TMP production at an integrated miscellaneous mill where groundwood and unbleached sulfite pulp are produced to manufacture newsprint and some market pulp. The data for this mill reflect the BOD5 contribution that would be expected from the production of newsprint from TMP pulp.

EPA reviewed the raw waste load information used to establish BPT effluent limitations for the groundwood-thermo-mechanical subcategory. The Agency found that the raw waste load was actually based on a mill where chemicals were added prior to refining. As shown in Table V-10, EPA revised the BPT BOD5 raw waste load to reflect the average load at mills where wood chips are pre-softened by heating, with no addition of chemicals.

Groundwood-CMN Papers. Available data on wastewater discharge and BOD5 and TSS raw waste loads are presented in Table V-11 for six mills where groundwood pulp is produced on-site using either stones or refiners. Average on-site pulp production is 73 percent based on total mill production. Major products include newsprint, molded, and other coarse and specialty groundwood products. Raw waste load characteristics are relatively constant for all mills representative of this subcategory with the exception of one mill (No. 052016) as presented in Table V-11. Average raw waste loads for this subcategory are higher than those used in the development of BPT limitations. Figures V-22 and V-23 present plots of raw waste flow and BOD5 versus the percentage of groundwood pulp produced relative to total production. No correlation is evident for either BOD5 or flow relative to the percentage of groundwood pulp used.

Groundwood-Fine Papers. Data are available on eight mills representative of this subcategory. Table V-12 presents available data on flow, BOD5, and TSS raw waste loadings. Printing grades of paper, both coated and uncoated, are produced at these mills from groundwood pulps produced on-site. Groundwood pulp relative to total production varies from 31 to 82.5 percent and averages 47 percent. The remainder of the furnish may be filler or coating pigments as well as purchased softwood and, to a lesser extent, hardwood pulps.

Raw waste flow and BOD5 have been plotted versus the percentage of groundwood pulp manufactured on-site relative to total production. These plots are presented on Figures V-24 and V-25. No apparent correlation exists between either BOD5 or flow to percentage of groundwood pulp manufactured.

FIGURE V-21

EFFECT OF CONDENSER TYPE ON RAW WASTE FLOW

PAPERGRADE SULFITE SUBCATEGORY

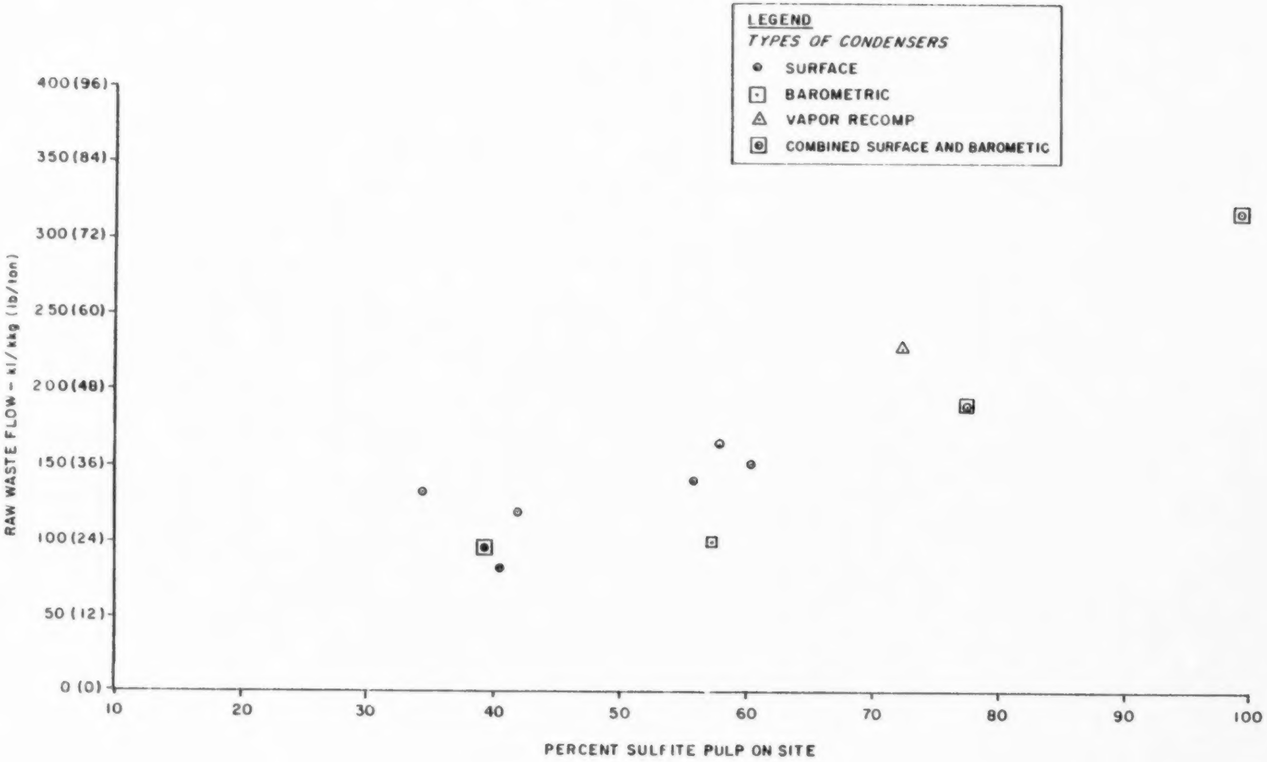


TABLE V-10

SUMMARY RAW WASTE LOAD DATA
GROUNDWOOD-THERMO-MECHANICAL SUBCATEGORY

	Production Profile				Raw Waste Load						
	Pulp (%)		Product		Flow		BOD5		TSS		
Mill No.	TMP	Other GWD	(t/d)	Type	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≤BPT(a)
070001	90	0	155	Coarse, Uncoated Printing	81.4	(19.5)	19.0	(38.0)	41.3	(82.5)	BF
070002(b)	88	12	497	Newsprint	33.4	(8.0)	16.2	(32.3)	43.4	(86.7)	BF
040003(c)	--	--	--	Newsprint	--	(--)	28.5	(57.0)	--	(--)	
Average					57.6	(13.8)	21.2	(42.4)	42.3	(84.6)	
BPT Raw Waste Load					88.0	(21.1)	39.2	(78.4)	39.9	(79.8)	
Assumed BPT Raw Waste Load					88.0	(21.1)	21.2	(42.4)	39.9	(79.8)	
Average of Mills with ≤BPT flow					57.6	(13.8)	17.6	(35.2)	42.3	(84.6)	
Average of Mills with ≤ Assumed BPT BOD5					57.6	(13.8)	17.6	(35.2)	42.3	(84.6)	

(a) F - Mill with ≤BPT flow; B - Mill with ≤ Assumed BPT BOD5.
(b) Supplemental data submitted by mill for 3/79 - 7/79.
(c) Data are representative of groundwood-thermo-mechanical operation; because other pulping operations are employed, mill is currently classified as integrated miscellaneous.

TABLE V-11

SUMMARY RAW WASTE LOAD DATA
GROUNDWOOD-CMN PAPERS SUBCATEGORY

	Production Profile				Raw Waste Load						
	GWD Furnish		Product		Flow		BOD5		TSS		
Mill No.	%	(t/d)	(t/d)	Type	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	SBPT(a)
052015	78.7	74	94	Newsprint, Fine	99.7	(23.9)	--	(--)	--	(--)	
052016	79.2	369	465	Newsprint	46.7	(11.2)	20.0	(40.0)	--	(--)	F
054004(b)	61.5	39	64	Molded	94.3	(22.6)	27.0	(53.9)	103.6	(207.2)	F
054006(c)	72.4	(c)	(c)	Molded	109.3	(26.2)	19.1	(38.2)	56.4	(112.7)	
054010(b)	72.7	8	11	Molded	121.9	(29.2)	--	(--)	--	(--)	
054015	70.5	693	983	Newsprint, Specialties	118.9	(28.5)	21.4	(42.7)	47.3	(94.5)	
Average	72.5				98.5	(23.6)	21.9	(43.7)	69.1	(138.1)	
BPT Raw Waste Load					99.3	(23.8)	17.4	(34.8)	48.5	(97.0)	

(a) F-Mill with SBPT flow.
(b) Mill is now closed.
(c) Production data held confidential.

FIGURE V-22
RAW WASTE FLOW VERSUS PERCENT GROUNDWOOD PULP ON SITE
GROUNDWOOD-CMN PAPERS SUBCATEGORY

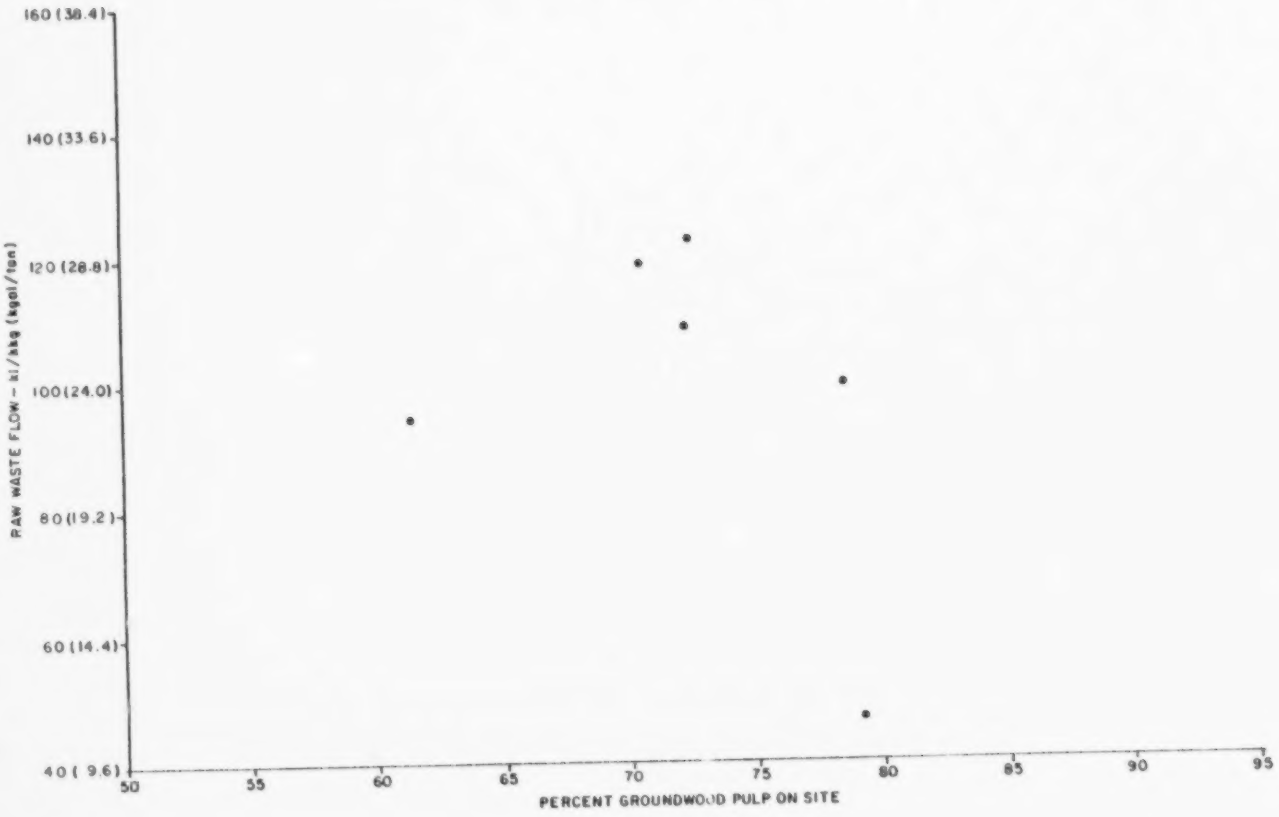


FIGURE V-23
RAW WASTE BOD_5 VERSUS PERCENT GROUNDWOOD PULP ON SITE
GROUNDWOOD-CMN PAPERS SUBCATEGORY

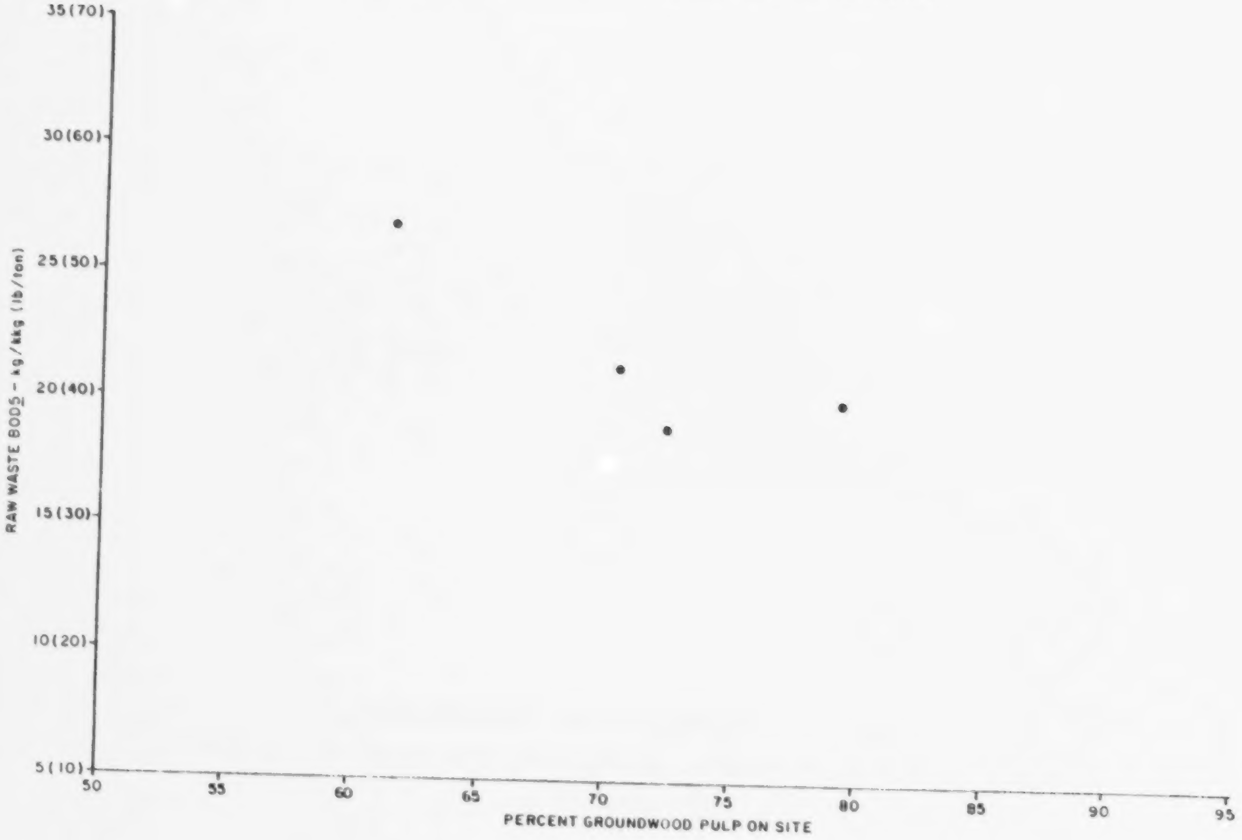


TABLE V-12

SUMMARY RAW WASTE LOAD DATA
GROUNDWOOD-FINE PAPERS SUBCATEGORY

	Production Profile			Raw Waste Load						
		Product		Flow		BOD5		TSS		
Mill No.	GWD Pulp (%)	(t/d)	Type	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≤BPT (b)
052003	51.0	535	Printing	88.1	(21.1)	12.2	(24.3)	61.0	(122.0)	BF
052004	31.0	481	Coated	65.9	(15.8)	28.6	(57.2)	79.2	(158.4)	F
052005	39.1	755	Printing	55.5	(13.3)	27.8	(55.6)	56.7	(113.3)	F
052007	58.0	224	Printing	96.8	(23.2)	--	(--)	--	(--)	
052008	41.8	787	Coated	54.7	(13.1)	10.1	(20.1)	56.0	(112.0)	BF
052013	38.5	(a)	Coated	70.1	(16.8)	15.6	(31.2)	41.4	(82.7)	BF
052014	34.0	285	Coated	54.7	(13.1)	12.0	(24.0)	36.9	(73.7)	BF
054014	82.5	76	Printing Specialties	61.3	(14.7)	16.8	(33.6)	46.6	(93.2)	F
Average	47.0			68.4	(16.4)	17.6	(35.1)	54.0	(107.9)	
BPT Raw Waste Load				91.0	(21.9)	16.7	(33.3)	52.5	(105.0)	
Average of Mills with ≤BPT flow				64.3	(15.4)	17.6	(35.1)	54.0	(107.9)	
Average of Mills with ≤BPT BOD5				66.8	(16.0)	12.5	(24.9)	48.8	(97.6)	

(a) Production data held confidential.
(b) F-Mill with ≤BPT flow; B-Mill with ≤BPT BOD5.

FIGURE V-24
RAW WASTE FLOW VERSUS PERCENT GROUNDWOOD PULP ON SITE
GROUNDWOOD-FINE PAPERS SUBCATEGORY

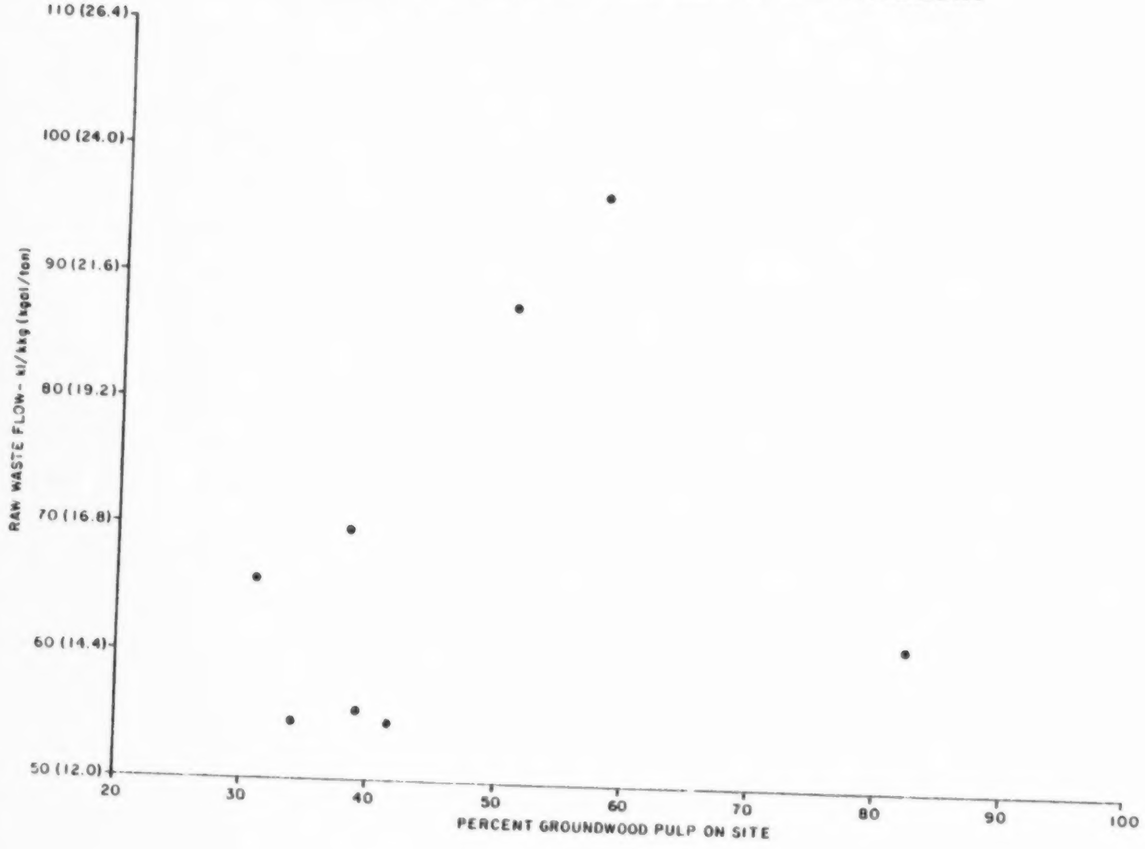
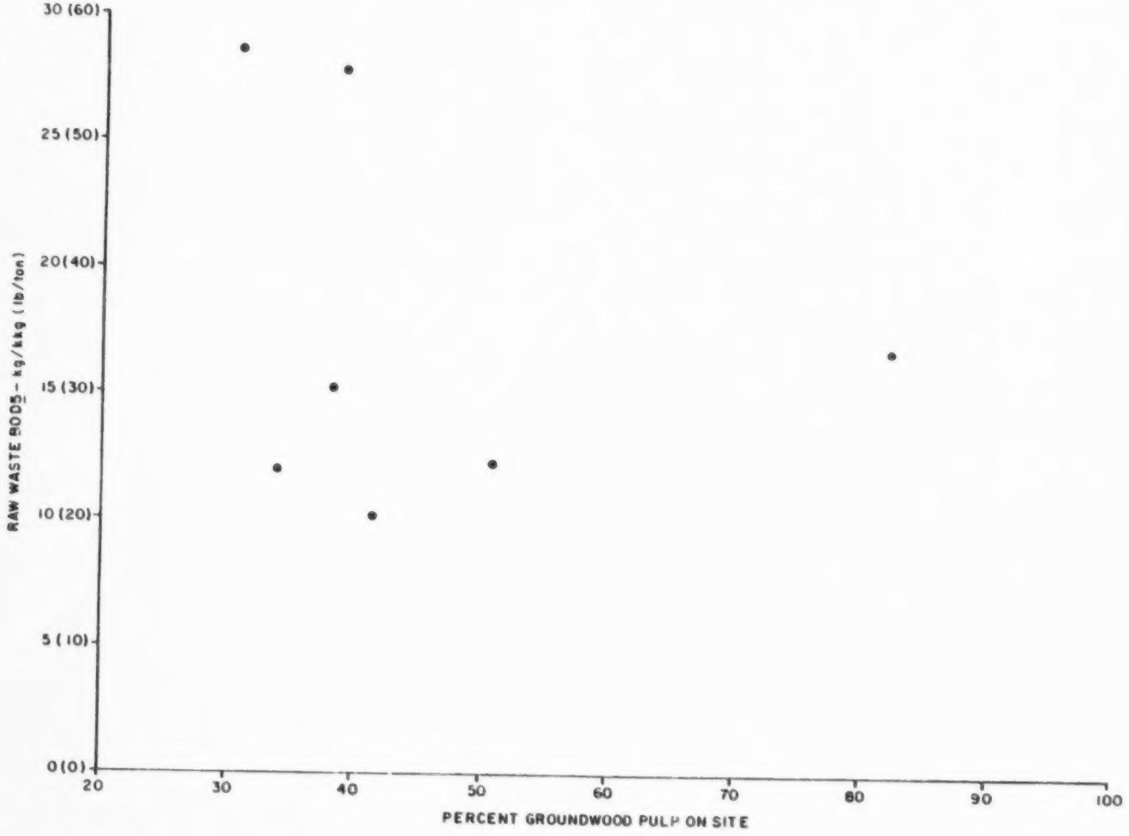


FIGURE V-25
RAW WASTE BOD$_5$ VERSUS PERCENT GROUNDWOOD PULP ON SITE
GROUNDWOOD-FINE PAPERS SUBCATEGORY



Integrated Miscellaneous Mills. Available data on wastewater discharge and BOD5 and TSS raw waste loadings at all remaining mills with on-site production of pulp(s) are tabulated in Table V-13. At these mills, multiple pulping operations or miscellaneous pulping processes not adequately described by specific subcategory definitions are employed. Information is also provided on the types of pulp(s) produced and the various products manufactured on-site.

Deink. Flow, BOD5, and TSS raw waste load data are available on 20 mills representative of this subcategory and are shown in Table V-14. At these mills, printing grades of paper, tissue, or newsprint are produced.

Raw waste flow and BOD5 data were evaluated to determine if the type of product manufactured or the percentage of deinked pulp relative to total production affects raw waste loadings. In Figures V-26 and V-27, data on flow and BOD5 are plotted relative to the percentage of deink pulp produced on-site. No apparent correlation exists between flow and BOD5 raw waste loads as a function of the percentage of deinked pulp produced on-site.

However, because of differences in flow and BOD5 raw waste loads, EPA concluded that the deink subcategory should be divided into three separate groupings: fine, tissue, and newsprint. Generally deink mills where tissue is produced exhibit the highest flow, BOD5, and TSS raw waste loads, while mills where newsprint is produced have the lowest raw waste loads. The average raw waste loads for each of these product sectors is shown on Table V-14.

Tissue from Wastepaper. Data are available for 21 mills representative of this subcategory. Principal products are sanitary and industrial tissue, including industrial packaging, wadding, and packaging and wrapping tissue. At these mills, mixed wastepaper is generally processed with little preparation, except for screening and cleaning prior to paper production on the papermachine.

Table V-15 presents available data on wastewater discharge and BOD5 and TSS raw waste loadings. There are nine mills where industrial grades and 12 where sanitary grades of tissue are made. There are no significant differences in raw waste loadings for industrial grade mills compared to sanitary tissue mills.

Paperboard from Wastepaper. Data are available for 146 mills representative of this subcategory, which is the largest in terms of number of mills in the pulp, paper, and paperboard industry. Raw waste load data are presented in Table V-16. Flow, BOD5, and TSS raw waste loadings are low compared to other industry subcategories. Mill sizes range from 0.5 to 871 kkg/day (0.6 to 960 tons/day), averaging 129 kkg/day (142 tons/day). Products made at mills in this subcategory include linerboard, corrugated board, chip and filler, folding boxboard, set-up box, gypsum board, and other construction boards, packaging materials, and automotive boards. At most mills, three or more types of products are produced on-site.

TABLE V-13

SUMMARY RAW WASTE LOAD DATA
INTEGRATED MISCELLANEOUS MILLS

Mill No.	Production Profile (t/d Furnish)(a)								Raw Waste Load					
									Flow		BOD5		TSS	
	A	B	C	D	E	F	G	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
010010	41K	798UK	903USK	--	--	--	112	1,854	131.9	(31.6)	15.3	(30.6)	9.4	(18.8)
010011	3K	156U	865U	--	454	--	--	1,478	58.0	(13.9)	10.5	(21.0)	22.2	(44.4)
010012	209K	335UK	336UK	--	--	--	9	889	123.9	(29.7)	18.6	(37.2)	12.4	(24.8)
010013	101K	751UK	--	--	--	--	--	852	109.7	(26.3)	22.0	(43.9)	59.1	(118.1)
010014	137K	1,193U	--	--	--	--	--	1,330	86.8	(20.8)	19.6	(39.1)	17.2	(34.3)
010015	232K	264U	682U	--	--	--	--	1,178	42.1	(10.1)	19.6	(39.2)	27.3	(54.6)
010022	140K	--	1,007U	--	--	--	--	1,146	60.9	(14.6)	38.3	(76.5)	--	--
010026	135K	505UK	--	--	--	208K	33K	881	179.9	(43.1)	52.3	(104.5)	60.3	(120.5)
010027	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	111.0	(26.6)	34.5	(68.9)	--	--
010039	--	--	617U	--	326	--	--	943	--	--	--	--	--	--
010050	615K	--	750U	--	--	--	--	1,365	--	--	--	--	--	--
010056	--	--	1,590USK	--	--	--	--	1,590	73.4	(17.6)	32.7	(65.4)	21.7	(43.4)
010059	--	--	934US	--	--	--	--	934	57.6	(13.8)	15.5	(31.0)	29.5	(58.9)
015010	638UK	--	259US	23K	--	--	--	920	105.2	(25.2)	50.7	(101.4)	55.0	(110.0)
030003	--	310U	975US	878W	--	--	--	2,163	73.0	(17.5)	18.9	(37.7)	20.2	(40.4)
030007	--	633UK	528KU	--	--	--	--	1,161	138.5	(33.2)	36.2	(72.3)	229.0	(458.0)
030008	20K	416UK	406K	--	--	245	--	1,087	173.6	(41.6)	38.4	(76.7)	8.3	(16.5)
030011	251K	--	--	394K	--	--	--	645	157.3	(37.7)	32.0	(63.9)	76.3	(152.5)
030014	--	169K	--	527K	--	713	11K	1,420	--	--	--	--	--	--
030016	--	--	1,137UK	--	--	--	--	1,137	131.4	(31.5)	25.2	(50.3)	52.3	(104.6)
030017	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	255.0	(61.1)	65.8	(131.5)	57.5	(115.0)
030019	494	--	--	100KG	226	--	--	820	--	--	--	--	--	--
030021	698	--	--	292E	593	--	--	1,583	88.5	(21.2)	27.6	(55.1)	53.2	(106.4)
030025	168K	--	--	439K	--	--	--	607	97.6	(23.4)	30.5	(60.9)	28.5	(57.0)
030029	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	245.8	(58.9)	43.2	(86.3)	66.7	(133.4)
030035	--	--	1,050K	--	454	--	--	1,504	83.9	(20.1)	32.5	(65.0)	74.4	(148.8)
030036	--	--	--	--	--	--	--	--	--	--	--	--	--	--
030038(c)	--	--	1,410UK	--	--	--	--	1,410	--	--	--	--	--	--
030040	185K	119KU	--	431K	--	101K	--	836	160.7	(38.5)	27.9	(55.7)	--	--
030041	164K	--	--	140K	--	49K	--	353	128.9	(30.9)	24.7	(49.4)	59.2	(118.3)
030043	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	139.0	(33.3)	19.5	(39.0)	24.4	(48.8)
030044	92K	--	670K	854K	--	--	--	1,616	124.4	(29.8)	35.9	(71.7)	86.6	(173.2)
030050	--	--	1,549KS	--	--	--	--	1,549	--	--	--	--	--	--
030053	--	967UK	--	--	356	--	--	1,323	109.7	(26.3)	28.5	(57.0)	43.1	(86.1)
030054	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	147.7	(35.4est)	47.8	(95.5)	113.1	(226.2)
030055	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	161.1	(38.6)	30.6	(61.1)	43.4	(86.8)
030056	--	413KU	168K	1,019K	--	--	--	1,600	102.2	(24.5)	28.8	(57.5)	26.3	(52.5)
040003	72L	--	--	--	420LOG	--	--	493	93.1	(22.3)	39.6	(79.1)	94.3	(188.6)
040004	--	--	--	185L	--	--	--	185	191.5	(45.9)	98.7	(197.3)	12.2	(24.3)
040005	--	--	--	--	--	173LP	--	173	50.1	(12.0)	58.8	(117.5)	17.7	(35.4)

TABLE V-13 (Continued)

Mill No.	Production Profile (t/d furnish)(a)								Raw Waste Load					
									Flow		BOD5		TSS	
	A	B	C	D	E	F	G	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
052006	--	--	78GR	50G	--	--	--	128	160.2	(38.4)	27.0	(53.9)	70.8	(141.6)
052009	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	98.9	(23.7est)	14.4	(28.7est)	12.1	(24.2est)
052010	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	107.7	(25.8)	24.7	(49.4)	69.5	(138.9)
052011	--	--	29R	517G	--	--	--	546	68.4	(16.4)	13.6	(27.2)	51.6	(103.2)
052017	27G	--	--	--	--	--	--	27	--	--	--	--	--	--
054001	--	--	--	--	--	--	3G	3	--	--	--	--	--	--
054002	112G	--	--	--	--	--	--	112	--	--	--	--	--	--
054003	--	--	--	118GK	919GK	--	--	1,037	75.9	(18.2)	12.0	(24.0)	55.8	(111.5)
054005	54K	--	--	99GK	1,412GKX	--	--	1,565	98.5	(23.6)	26.6	(53.2)	44.8	(89.5)
054008	--	--	--	495GP	--	--	--	495	69.7	(16.7)	12.1	(24.2)	39.6	(79.1)
054009	--	--	256GP	--	--	--	37GP	293	--	--	--	--	--	--
054011	--	--	--	--	575GLO	17GLO		592	86.8	(20.8)	26.2	(52.4)	72.7	(145.3)
054012	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	--	--	--	--	--	--
054013	--	--	5R	10P	--	--	30	45	179.4	(43.0)	17.9	(35.8)	97.4	(194.8)
054016	290GL	16GGL	--	1,201GL	45GL		--	1,552	75.1	(18.0)	21.9	(43.8)	18.8	(37.6)
054017	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	55.9	(13.4)	12.8	(25.5)	42.7	(85.4)
060001	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	105.2	(25.2)	43.0	(86.0)	18.8	(37.5)
060002	--	--	--	400NK	--	--	--	400	66.8	(16.0)	31.3	(62.5)	103.5	(207.0)
060003(c)	207M	--	--	--	--	--	--	207	80.1	(19.2)	45.7	(91.3)	55.3	(110.6)
080010	--	--	--	13GT	--	--	--	13	350.9	(84.1)	--	--	28.5	(57.0)
080011	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	96.4	(23.1)	7.4	(14.7)	--	--
080012	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	1,256.1	(301.0)	29.3	(58.6)	--	--
080013	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	131.9	(31.6)	3.9	(7.8)	--	--
080014	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	154.8	(37.1)	7.6	(15.1)	--	--
080015	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	301.7	(72.3)	3.6	(7.2)	--	--
080016	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	43.0	(10.3)	6.8	(13.6)	--	--
080020	--	--	--	--	--	--	11T	11	1,684.2	(403.6)	46.8	(93.6)	32.0	(63.9)
080023	--	--	--	36TP	--	--	--	36	131.0	(31.4)	40.3	(80.6)	47.9	(95.8)
080025	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	217.8	(52.2)	49.4	(98.8)	100.2	(200.3)
080035(d)	--	--	--	14T	--	--	--	14	250.8	(60.1)	31.4	(62.8)	51.8	(103.5)
080052	--	--	--	60PKT	--	--	3P	63	53.8	(12.9)	14.5	(28.9)	38.2	(76.3)
080054	--	--	--	53T	--	--	--	53	--	--	--	--	--	--
085003(c)	--	--	3GP	--	--	--	--	3	12.9	(3.1)	2.8	(5.6)	14.1	(28.1)
105006(c)	--	--	--	--	--	--	--	7.5	--	--	--	--	--	--
105046	--	--	--	--	--	--	6T	6	336.8	(80.7)	46.3	(92.5)	73.3	(146.5)
105063	--	--	--	--	--	--	32N	32	467.8	(112.1)	104.4	(208.7)	102.8	(205.6)
105064	--	--	--	--	--	--	21T	21	842.5	(201.9)	140.5	(281.0)	167.3	(334.5)
140001	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	--	--	--	--	--	--
150001	--	--	150SN	--	--	--	--	150	-------------------	------	Self-Contained	------	------	------
150012	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	241.2	(57.8)	18.5	(37.0)	11.4	(22.7)
150014	79T	--	--	--	--	--	--	79	42.6	(10.2)	41.8	(83.6)	13.7	(27.3)
150015	5N	--	--	--	--	--	--	5	--	--	--	--	--	--
150016	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	162.3	(38.9)	200.7	(401.3)	328.1	(656.1)
150017	2T	--	--	--	--	--	--	2	154.4	(37.0)	71.1	(142.2)	48.3	(96.5)

T\BLE V-13 (Continued)

Mill No.	Production Profile (t/d furni:h) (a)								Raw Waste Load					
									Flow		BOD5		TSS	
	A	B	C	D	E	F	G	Total	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
150018	85T	--	--	--	--	--	--	85	122.7	(29.4)	3.8	(7.6)	11.8	(23.5)
150020	8N	--	--	123N	--	--	--	131	--	--	577.6	(1155.2)	441.0	(882.0)
150026	18T	--	--	--	--	--	--	18	74.7	(17.9)	--	--	67.6	(135.2)
150029	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)	--	--	--	--	--	--

(a) Product Designations

A. Market Pulp
B. Packaging and Converting Products
C. Board and Construction Products
D. Printing Writing and Related Papers
E. Newsprint
F. Sanitary Tissue
G. Other - Includes specialty, thin, synthetic, non-wood (other than cotton writing), construction, and molded papers.

Furnish Designations

G. Groundwood
K. Kraft, bleached
U. Kraft, unbleached
S. Semi-Chemical
T. Cotton
R. Recycled Pulp (Wastepaper)
N. Non-wood (Other than cotton, includes synthetics)
M. Chemi-Mechanical
L. Sulfite
P. Greater than 50% purchased pulp
O. Thermo-Mechanical
X. Soda
Y. Deinked

(b) Production data held confidential.
(c) Mill is closed.
(d) Mill was an integrated miscellaneous mill at time of data collection, but has subsequently ceased pulping operations and is now classified as Nonintegrated-Fine Papers (Cotton Fiber Furnish).

TABLE V-14

SUMMARY RAW WASTE LOAD DATA
DEINK SUBCATEGORY

	Production Profile							Raw Waste Load						
	Furnish (t/d)					Product		Flow		BOD5		TSS		
				Purch (t/d)										
Mill No.	(t/d)(a)	%(b)	WP	Pulp	Broke	(t/d)	Type	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≤BPT (c)
Deink Fine														
140005	188	51	--	166	19	379	Unctd Print Writing	100.1	(24.0)	17.4	(34.8)	197.3	(394.6)	BF
140007	155	57	55	54	41	349	Ctd & Unctd Printing	53.8	(12.9)	55.0	(110.0)	162.1	(324.1)	BF
140008	77	62	9	10	29	128	Unctd Print Writing	114.8	(27.5)	72.8	(145.5)	189.0	(377.9)	B
140017	(d)	61	(d)	(d)	(d)	(d)	Ctd Print	126.0	(30.2)	20.4	(40.7)	216.0	(432.0)	B
140019	43	60	--	8	18	65	Unctd Print	44.7	(10.7)	20.9	(41.8)	106.0	(211.9)	BF
Average								88.1	(21.1)	37.3	(74.6)	174.1	(348.1)	
BPT Raw Waste Load								102.0	(24.4)	90.0	(180.0)	202.5	(405.0)	
Average of Mills with ≤BPT flow								66.4	(15.9)	31.1	(62.2)	155.1	(310.2)	
Average of Mills with ≤BPT BOD5								88.1	(21.1)	37.3	(74.6)	174.1	(348.1)	
Deink Tissue														
140010	(d)	50	(d)	(d)	(d)	(d)	San Tissue	118.1	(28.3)	55.8	(111.6)	133.9	(267.7)	B
140029(e)	20	73	--	6	--	22	San Tissue	--	(--)	--	(--)	--	(--)	
140030(f)	60	40	30	30	--	100	San Tissue	75.1	(18.0)	56.7	(113.4)	166.6	(333.2)	BF
140011	(d)	96	(d)	(d)	(d)	(d)	San Tissue	90.6	(21.7)	104.3	(208.5)	292.1	(584.2)	F
140014	(d)	94	(d)	(d)	(d)	(d)	San Tissue	90.6	(21.7)	73.2	(146.3)	225.8	(451.5)	BF
140015	(d)	100	(d)	(d)	(d)	(d)	Tissue	139.8	(33.5)	--	(--)	--	(--)	
140018(g)	36	97	--	--	1	36	Ind Wrap,Tissue	25.5	(6.1)	--	(--)	--	(--)	F
140021	170	87	--	--	20	150	San Tissue	205.7	(49.3)	80.3	(160.5)	247.3	(494.5)	B
140022	56	48	--	26	6	50	San Tissue	166.9	(40.0)	--	(--)	--	(--)	
140024	(d)	100	(d)	(d)	(d)	(d)	San Tissue	203.2	(48.7)	148.3	(296.5)	320.8	(641.6)	
140025	92	85	--	4	11	100	San Tissue	62.6	(15.0)	35.9	(71.8)	161.6	(323.2)	BF
140028	(d)	99	(d)	(d)	(d)	(d)	San Tissue	156.1	(37.4)	112.6	(225.1)	375.2	(750.3)	
Average								136.9	(32.8)	87.2	(174.3)	251.0	(501.9)	
BPT Raw Waste Load								102.0	(24.4)	90.0	(180.0)	202.5	(405.0)	
Average of Mills with ≤BPT flow								81.4	(19.5)	71.1	(142.2)	226.5	(453.0)	
Average of Mills with ≤BPT BOD5								119.3	(28.6)	61.3	(122.6)	192.1	(384.2)	
Deink Newsprint(g)														
140002(h)														
140003(h)														
140013(h)														
Average								67.6	(16.2)	15.9	(31.7)	96.8	(193.5)	

(a) Wastepaper to deink process.

(b) Percentage of deink pulp used calculated by subtracting wastepaper, purchased pulp, and purchased broke from final daily production, assuming this is equal to the amount of deink pulp utilized, then dividing by the final daily production.

(c) F - Mill with ≤BPT flow.
B - Mill with ≤BPT BOD5.

(d) Production data held confidential.

(e) Self-contained; not included in averages.

(f) Operates with low deink use. Not included in averages.

(g) Produces a coarse grade and recirculates approximately 50% of its treated effluent. Not included in averages.

(h) Production and raw waste load data held confidential.

FIGURE V-26
RAW WASTE FLOW VERSUS PERCENT DEINK PULP PRODUCED
DEINK SUBCATEGORY

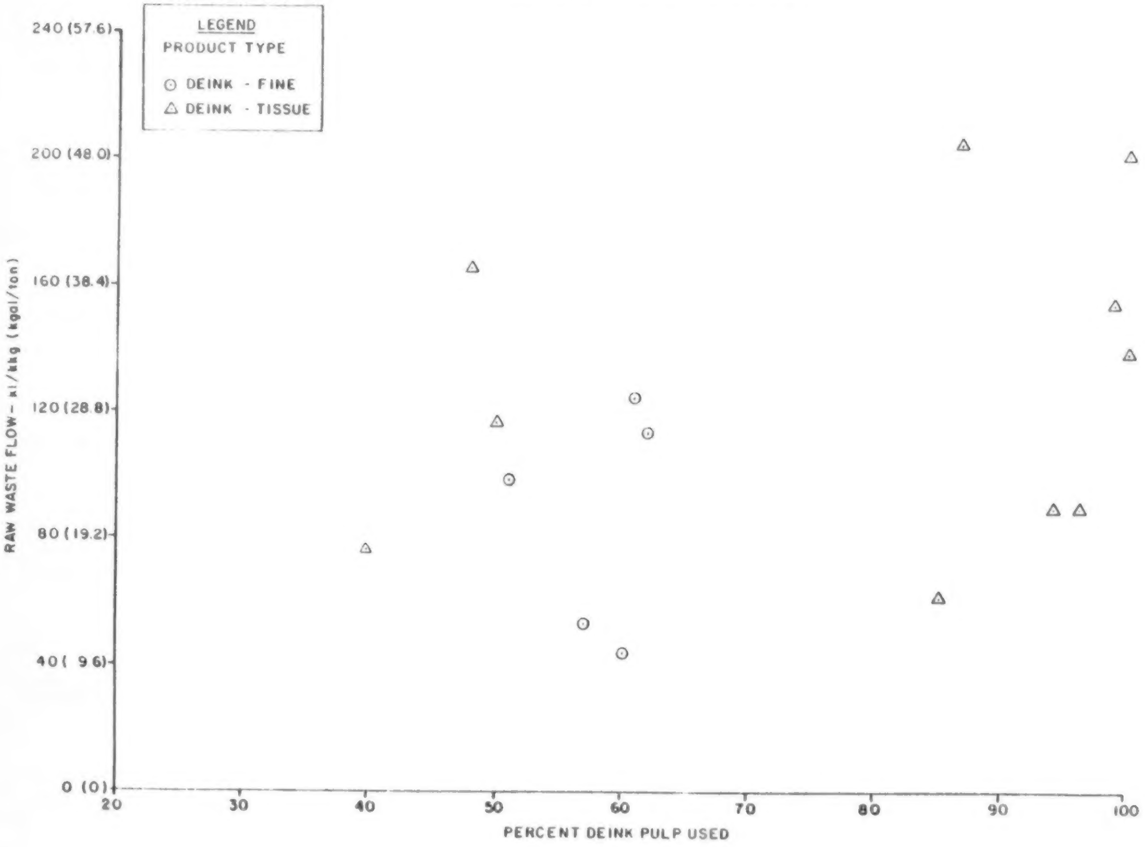


FIGURE V-27
RAW WASTE BOD5 VERSUS DEINK PULP PRODUCED
DEINK SUBCATEGORY

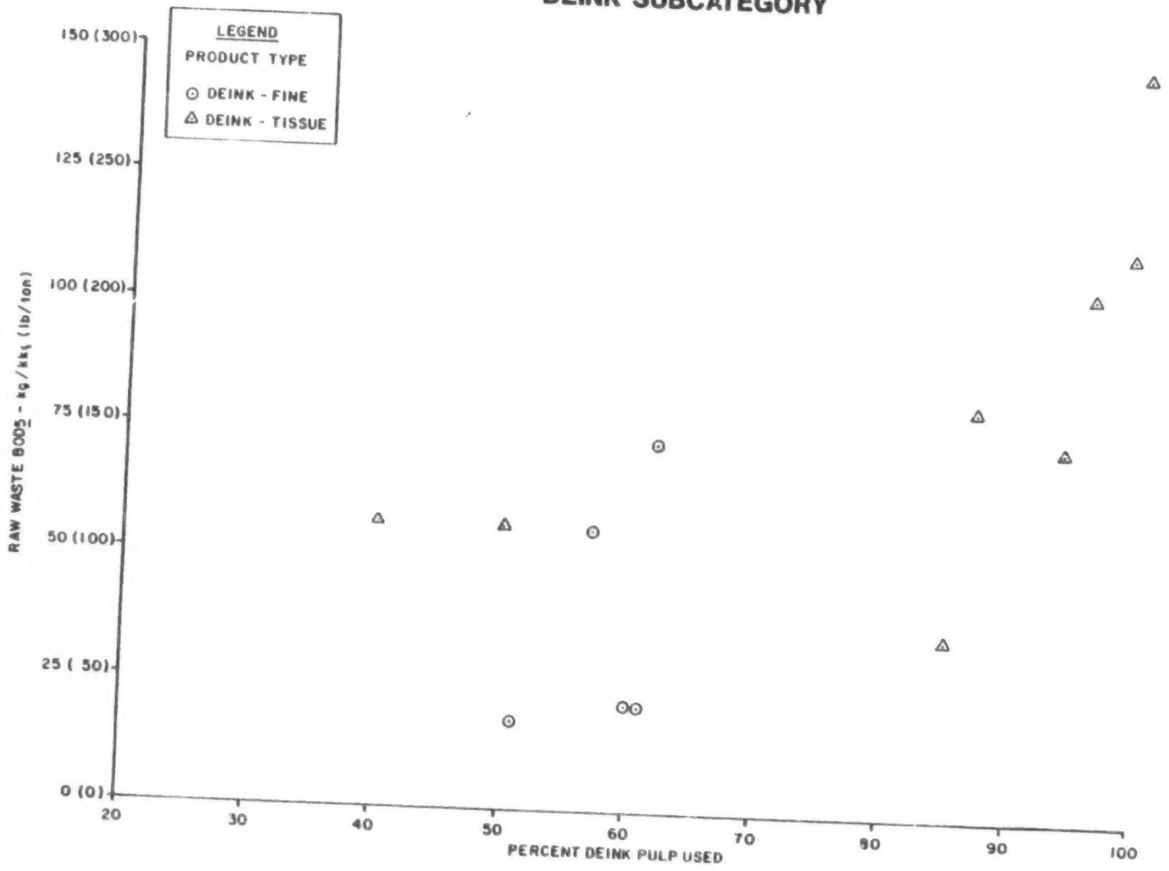


TABLE V-15

SUMMARY RAW WASTE LOAD DATA
TISSUE FROM WASTEPAPER SUBCATEGORY

Mill No.	Production (t/d)	Raw Waste Load Flow kl/kkg	Flow (kgal/t)	BOD5 kg/kkg	BOD5 (lb/t)	TSS kg/kkg	TSS (lb/t)	≤BPT(b)
I. Industrial Tissue								
090002	19.5	72.6	(17.4)	--	(--)	--	(--)	F
085004	47.0	141.9	(34.0)	22.4	(44.7)	106.4	(212.8)	
085006	(a)	138.1	(33.1)	37.6	(75.1)	103.3	(206.5)	
090006(c)	10.5	29.2	(7.0)	--	(--)	46.7	(93.3)	
100005	15.2	62.2	(14.9)	14.2	(28.4)	38.0	(76.0)	BF
100011	11.2	Self-contained						
100012(c)	7.0	35.5	(8.5)	--	(--)	--	(--)	
100015	5.5	Self-contained						
100001	(a)	84.7	(20.3)	6.5	(13.0)	13.3	(26.5)	BF
Average w/o Self-Contained Mills		99.7	(23.9)	20.2	(40.3)	65.3	(130.5)	
II. Sanitary Tissue								
090004	20.0	59.7	(14.3)	--	(--)	--	(--)	F
090010	(a)	76.8	(18.4)	18.8	(37.6)	59.4	(118.7)	F
100002	7.5	Self-contained						
100003	83.0	51.7	(12.4)	8.7	(17.3)	9.2	(18.4)	BF
100004	15.0	Self-contained						
100007(d)	20.0	Self-contained						
100008	16.0	Self-contained						
100013	20.0	156.5	(37.5)	9.3	(18.6)	88.9	(177.8)	B
100016	7.3	237.9	(57.0)	53.5	(107.0)	128.0	(255.9)	
105007(c)	11.9	22.1	(5.3)	--	(--)	--	(--)	
090014	40.7	138.5	(33.2)	22.0	(44.0)	68.2	(136.3)	
100014(c)(d)	20.7	9.2	(2.2)	--	(--)	--	(--)	
Average w/o Self-Contained Mills		120.2	(28.8)	22.5	(44.9)	70.7	(141.4)	
Overall Average w/o Self-Contained Mills		111.0	(26.6)	21.5	(42.9)	68.3	(136.5)	
BPT Raw Waste Load		105.0	(25.2)	14.5	(29.0)	110.5	(221.0)	
Average of All Mills with ≤BPT flow		68.0	(16.3)	12.1	(24.1)	30.0	(59.9)	
Average of All Mills with ≤BPT BOD5		88.9	(21.3)	9.7	(19.3)	37.4	(74.7)	

(a) Production data held confidential.
(b) F-Mill with ≤BPT flow; B-Mill with ≤BPT BOD5.
(c) Extensive wastewater recycle performed; not included in averages.
(d) Mill is now closed.

TABLE V-16

SUMMARY RAW WASTE LOAD DATA
PAPERBOARD FROM WASTEPAPER SUBCATEGORY

Mill No.	Production Profile (t/d) (a)								Percent Corrugated Furnish	Raw Waste Load						
										Flow		BOD5		TSS		
	A	B	C	D	E	F	G	Total		kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	SBPT(b)
Noncorrugating Medium Furnish																
085002	-	-	-	-	-	-	35	35	56	--Self-Contained--						
085009	-	-	-	-	-	-	90	90	6	37.1	(8.9)	8.9	(17.7)	12.6	(25.2)	R
110001(e)	300	250	240	170	-	-	-	960	59	28.4	(6.8)	12.5	(25.0)	19.3	(38.5)	F
110002	-	-	45	-	-	-	-	45	33	0.4	(0.1)	2.0	(3.9)	10.8	(21.5)	FB
110003(e)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	19	20.9	(5.0)	--	(--)	--	(--)	F
110004	-	-	-	-	178	-	-	178	10	15.9	(3.8)	13.0	(25.9)	12.1	(24.2)	F
110005	-	-	16	130	16	-	-	162	46	--	(--)	--	(--)	--	(--)	
110006	-	-	-	127	-	-	-	127	24	10.0	(2.4)	32.3	(64.6)	23.6	(47.2)	F
110007	-	-	-	170	-	-	-	170	18	--Self-Contained--						
110008	-	-	-	58	14	-	-	72	45	16.3	(3.9)	20.3	(40.6)	6.4	(12.8)	F
110009	-	-	94	-	-	-	-	94	7	23.4	(5.6)	3.6	(7.1)	8.2	(16.3)	FB
110011	-	-	14	35	-	-	122	171	40	17.9	(4.3)	7.3	(14.6)	11.1	(22.2)	FB
110012	-	-	-	208	-	-	-	208	18	15.9	(3.8)	4.5	(9.0)	10.3	(20.6)	FB
110013	-	-	(410 C+D)		-	-	-	410	22	25.5	(6.1)	12.5	(25.0)	35.9	(71.7)	F
110015	-	-	-	-	-	-	79	79	0	--Self-Contained--						
110016	-	-	-	-	-	-	49	49	0	--Self-Contained--						
110017	-	-	-	-	-	-	84	84	0	2.5	(0.6)	--	(--)	--	(--)	F
110018	--no data given--								49	--Self-Contained--						
110019	-	-	-	18	25	-	36	79	20	--	(--)	--	(--)	--	(--)	
110020	-	-	-	9	23	-	54	86	17	--	(--)	--	(--)	--	(--)	
110022	-	-	-	23	-	-	17	40	28	76.4	(18.3)	14.1	(28.2)	29.8	(59.6)	
110023	-	138	-	-	-	-	-	138	56	--	(--)	--	(--)	--	(--)	
110024	-	223	90	-	-	-	24	337	71	4.2	(1.0)	3.2	(6.3)	2.3	(4.5)	FB
110026	-	-	-	-	-	-	150	150	0	--Self-Contained--						
110029	-	-	2	-	-	133	-	135	63	9.6	(2.3)	7.5	(14.9)	8.8	(17.5)	FB
110031	-	-	-	-	-	150	-	150	44	7.1	(1.7)	--	(--)	--	(--)	F
110032	-	-	-	74	-	-	-	74	61	--	(--)	--	(--)	--	(--)	
110033	96	-	-	-	-	-	-	96	82	--Self-Contained--						
110034	-	-	-	-	-	165	-	165	31	--	(--)	--	(--)	--	(--)	
110035	-	-	-	150	27	-	44	221	5	18.8	(4.5)	13.0	(26.0)	10.7	(21.4)	F
110036	-	-	-	61	-	-	-	61	9	8.3	(2.0)	3.7	(7.3)	1.3	(2.6)	FB
110037	-	-	-	89	57	-	20	166	28	--Self-Contained--						
110038	-	-	-	92	-	-	3	95	16	40.9	(9.8)	12.5	(24.9)	13.9	(27.8)	
110039	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	18	31.3	(7.5)	15.4	(30.8)	27.2	(54.3)	
110040	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	16	25.0	(6.0)	9.7	(19.4)	7.9	(15.7)	FB
110041	88	-	16	-	-	-	-	104	35	35.9	(8.6)	5.2	(10.4)	4.1	(8.1)	R
110043	-	-	130	30	-	-	-	160	46	18.8	(4.5)	1.0	(1.9)	1.1	(2.2)	FB
110044	-	-	108	-	-	-	-	-	39	--Self-Contained--						
110045	-	-	100	175	25	-	-	300	34	30.0	(7.2)	1.0	(2.0)	39.3	(78.5)	FB
110046	-	-	-	-	-	-	-	36	67	37.1	(8.9)	--	(--)	7.1	(14.2)	

TABLE V-16 (Continued)

Mill No.	Production Profile (t/d) (a)								Percent Corrugated Furnish	Raw Waste Load						BPT(b)
										Flow		BOD5		TSS		
	A	B	C	D	E	F	G	Total		kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	
110047	-	-	100	70	100	-	-	270	23	20.0	(4.8)	6.5	(13.0)	2.1	(4.1)	FB
110048	-	-	-	-	-	-	53	53	8	--	(--)	--	(--)	--	(--)	
110050	-	-	32	234	-	-	5	271	24	30.5	(7.3)	10.0	(20.0)	11.0	(21.9)	B
110051	-	-	40	146	-	-	9	195	33	45.5	(10.9)	10.7	(21.4)	13.1	(26.2)	B
110052	-	-	-	-	-	95	-	95	26	25.5	(6.1)	9.1	(18.1)	5.0	(10.0)	FB
110053	-	-	-	300	-	-	-	300	34	12.9	(3.1)	8.1	(16.2)	2.8	(5.5)	FB
110055	(153		A+B+C)	-	-	-	-	153	99	14.6	(3.5)	16.4	(32.7)	11.8	(23.5)	F
110056	10	-	-	-	55	-	-	65	47	21.7	(5.2)	9.2	(18.4)	7.1	(14.1)	FB
110058	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	44	14.2	(3.4)	10.0	(19.9)	11.9	(23.8)	FB
110059	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	56	42.1	(10.1)	16.5	(32.9)	26.2	(52.3)	
110060	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	1	--	(--)	--	(--)	--	(--)	
110061	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	32	31.3	(7.5)	9.1	(18.1)	8.6	(17.2)	B
110062	-	-	-	89	3	-	4	96	26	34.6	(8.3)	11.5	(22.9)	8.2	(16.4)	
110064	-	-	-	-	-	-	11	11	23	------------------Self-Contained------------------						
110065	-	-	-	-	-	76	-	76	--	--	(--)	--	(--)	--	(--)	
110066	-	-	-	-	120	-	-	120	20	5.4	(1.3)	7.7	(15.3)	9.8	(19.6)	FB
110067	-	-	-	-	-	-	58	58	23	28.8	(6.9)	1.5	(3.0)	1.5	(3.0)	FB
110068	-	-	-	-	-	-	437	437	49	7.5	(1.8)	6.5	(12.9)	--	(--)	FB
110069	-	-	-	134	-	-	-	134	34	30.9	(7.4)	7.4	(14.8)	16.5	(33.0)	B
110070	-	-	-	68	-	-	-	68	47	4.2	(1.0)	--	(--)	--	(--)	F
110071	-	-	-	-	-	-	58	58	61	--	(--)	--	(--)	--	(--)	
110072	-	-	-	-	-	-	152	152	0	34.6	(8.3)	10.4	(20.8)	26.6	(53.2)	B
110074	-	-	-	-	-	-	63	63	69	--	(--)	--	(--)	--	(--)	
110075	-	-	-	-	-	-	68	68	66	8.3	(2.0)	--	(--)	--	(--)	F
110076	-	-	-	-	-	-	99	99	54	4.2	(1.0)	5.1	(10.2)	2.5	(4.9)	FB
110077	-	-	-	-	-	-	175	175	81	--	(--)	--	(--)	--	(--)	
110078	-	-	-	-	-	-	63	63	75	2.5	(0.6)	--	(--)	--	(--)	
110079	-	-	-	-	-	-	61	61	81	11.3	(2.7)	--	(--)	6.9	(13.7)	F
110081	-	-	60	-	-	-	-	60	--	------------------Self-Contained------------------						
110082	-	-	45	40	30	-	-	115	19	79.7	(19.1)	5.2	(10.4)	3.5	(6.9)	B
110083	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	65	28.0	(6.7)	8.9	(17.8)	10.8	(21.5)	FB
110084	-	-	-	-	-	105	-	105	11	15.9	(3.8)	3.2	(6.4)	4.6	(9.1)	FB
110085(d)(e)		-	68	(102	D+E)	-	52	222	33	15.0	(3.6)	10.2	(20.3)	15.8	(31.5)	FB
110086	-	-	115	85	-	-	-	200	7	------------------Self-Contained------------------						
110087	-	-	-	442	-	-	-	442	41	27.5	(6.6)	67.5	(135.0)	16.9	(33.7)	F
110088	-	-	-	43	-	-	-	43	29	27.1	(6.5)	--	(--)	--	(--)	F
110089	-	-	-	35	-	-	-	35	11	--	(--)	--	(--)	--	(--)	
110090	-	-	54	3	20	-	-	77	22	11.7	(2.8)	11.3	(22.6)	7.5	(14.9)	F
110091	-	-	24	36	30	-	-	90	27	13.4	(3.2)	8.0	(15.9)	8.9	(17.8)	FB
110092	-	-	-	200	-	-	-	200	6	1.3	(0.3)	3.8	(7.5)	2.2	(4.3)	FB
110093	-	-	49	91	-	-	-	140	30	29.6	(7.1)	--	(--)	28.0	(55.9)	F
110094	-	-	-	-	-	99	-	99	21	--	(--)	--	(--)	--	(--)	
110095	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	30	12.5	(3.0)	21.7	(43.3)	4.0	(7.9)	F
110096	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	29	--	(--)	--	(--)	--	(--)	

TABLE V-16 (Continued)

Mill No.	Production Profile (t/d) (a)								Percent Corrugated Furnish	Raw Waste Load						
										Flow		BOD5		TSS		
	A	B	C	D	E	F	G	Total		kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≤BPT(b)
110097	1	-	93	-	-	-	112	206	92	15.9	(3.8)	10.3	(20.5)	2.1	(4.2)	FB
110098	40	-	5	54	8	-	1	128	53	13.8	(3.3)	--	(--)	--	(--)	F
110099	-	282	-	108	-	-	-	390	80	8.8	(2.1)	--	(--)	1.4	(2.8)	F
110100	-	-	61	-	-	-	-	61	60	12.9	(3.1)	--	(--)	--	(--)	F
110101	-	-	-	-	-	198	-	198	33	9.6	(2.3)	3.5	(7.0)	3.7	(7.3)	FB
110102	-	-	-	-	50	-	-	50	0	--	(--)	--	(--)	--	(--)	
110103	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	80	--	(--)	--	(--)	--	(--)	
110104	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	74	--	(--)	--	(--)	--	(--)	
110105	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	80	1.3	(0.3)	1.6	(3.1)	0.1	(0.2)	FB
110106	-	-	-	-	-	192	70	262	42	12.1	(2.9)	27.8	(55.6)	16.3	(32.5)	F
110107	-	-	-	(114	D+E)	-	-	114	16	--------------------Self-Contained--------------------						
110108	-	-	-	90	-	-	-	90	3	--	(--)	--	(--)	--	(--)	
110110	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	43	9.6	(2.3)	11.2	(22.4)	13.3	(26.5)	FB
110111	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	21	17.1	(4.1)	3.6	(7.2)	4.2	(8.4)	FB
110112	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	21	8.8	(2.1)	3.4	(6.8)	5.0	(10.0)	FB
110113	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	62	15.9	(3.8)	5.1	(10.1)	34.0	(68.0)	FB
110114	-	-	-	136	-	-	-	136	26	6.7	(1.6)	2.5	(5.0)	0.1	(0.2)	FB
110115	-	6	200	-	-	-	-	206	43	--	(--)	--	(--)	--	(--)	
110116	-	-	-	-	-	-	27	27	0	------------------Self-Contained------------------						
110117	-	-	-	6	3	-	70	79	46	5.4	(1.3)	4.4	(8.7)	3.4	(6.7)	FB
110118	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	0	14.6	(3.5)	--	(--)	--	(--)	F
110119	-	-	-	-	-	-	54	54	44	28.0	(6.7)	6.1	(12.1)	2.8	(5.5)	FB
110120	-	-	30	-	-	-	12	42	32	10.8	(2.6)	7.5	(15.0)	1.5	(3.0)	FB
110121	-	74	-	-	96	-	-	170	69	7.1	(1.7)	1.2	(2.4)	1.5	(2.9)	FB
110123	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	53	18.4	(4.4)	11.0	(22.0)	9.4	(18.8)	FB
110124	27	-	101	-	-	-	-	128	2	45.5	(10.9)	12.8	(25.5)	32.6	(65.2)	
110125	-	-	-	6	24	-	69	99	3	1.3	(0.3)	1.0	(2.0)	1.5	(3.0)	FB
110126	-	-	-	195	-	-	-	195	29	23.4	(5.6)	0.8	(1.5)	0.5	(0.9)	FB
110127	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	45	52.2	(12.5)	12.5	(25.0)	19.5	(39.0)	
110128	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	69	--	(--)	--	(--)	--	(--)	
110129	-	-	14	76	-	-	-	90	38	--	(--)	--	(--)	--	(--)	
110130	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	14	6.7	(1.6)	--	(--)	--	(--)	F
110131(e)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	54	14.2	(3.4)	1.9	(3.8)	0.3	(0.6)	FB
110133(e)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	74	--	(--)	--	(--)	--	(--)	
110134	-	-	38	-	-	-	-	38	40	--	(--)	--	(--)	--	(--)	
110135	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	47	------------------Self-Contained------------------						
110138	-	-	66	41	-	11	-	118	41	18.8	(4.5)	8.9	(17.7)	18.1	(36.1)	FB
110140	-	-	-	-	-	220	-	220	45	10.0	(2.4)	4.9	(9.8)	4.9	(9.7)	FB
110141(g)	20	-	49	30	-	-	5	104	15	20.0	(4.8)	--	(--)	--	(--)	F
110142	61	-	-	12	-	16	122	211	95	------------------Self-Contained------------------						
110143	-	-	85	-	-	-	123	208	53	9.2	(2.2)	7.0	(13.9)	--	(--)	FB
110144	-	-	7	13	42	-	-	62	24	--	(--)	--	(--)	--	(--)	
110145(e)	-	-	-	234	-	-	-	234	42	--	(--)	--	(--)	--	(--)	
110146	-	23	20	-	-	-	-	43	98	------------------Self-Contained------------------						
110147(f)	-	49	15	-	-	-	-	64	--	7.1	(1.7)	1.1	(2.2)	0.7	(1.4)	FB
110148	-	-	-	-	115	-	-	115	22	10.8	(2.6)	1.8	(3.5)	2.2	(4.4)	FB

TABLE V-16 (Continued)

Mill No.	Production Profile (t/d) (a)								Percent Corrugated Furnish	Raw Waste Load						≤BPT(b)
										Flow		BOD5		TSS		
	A	B	C	D	E	F	G	Total		kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	
110149	-	3	-	-	-	-	-	3	73	1.7	(0.4)	--	(--)	--	(--)	F
110150	25	35	-	-	-	-	-	60	57	--	(--)	--	(--)	--	(--)	
110151	20	28	-	-	-	-	-	48	55	--	(--)	--	(--)	--	(--)	
110152	-	-	(115	C+D+E)		-	-	115	18	12.9	(3.1)	4.3	(8.6)	6.4	(12.8)	FB
150019	-	-	-	-	-	-	1	1	0	20.0	(4.8)	--	(--)	--	(--)	F
Average of <100 percent corrugated furnish mills (w/o self-contained mills)										19.2	(4.6)	9.2	(18.4)	10.4	(20.8)	
BPT Raw Waste Load										30.0	(7.2)	11.3	(22.5)	11.0	(21.9)	
Average of <100 percent corrugated furnish mills ≤BPT flow										14.2	(3.4)	8.8	(17.5)	8.7	(17.4)	
Average of <100 percent corrugated furnish mills ≤BPT BOD5										17.5	(4.2)	5.9	(11.7)	7.8	(15.5)	
Corrugating Medium Furnish																
110010	-	-	-	-	-	-	10	10	100	--	(--)	--	(--)	--	(--)	
110014	-	90	-	-	-	-	-	90	100	3.3	(0.8)	13.2	(26.4)	11.1	(22.2)	FB
110025	45	408	-	-	-	-	-	453	100	10.8	(2.6)	19.3	(38.6)	2.3	(4.6)	FB
110028	-	83	-	-	-	-	-	83	100	0.8	(0.2)	0.6	(1.2)	1.3	(2.6)	FB
110030	-	126	-	-	-	-	-	126	100	5.0	(1.2)	--	(--)	5.1	(10.2)	F
110049	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	100	2.9	(0.7)	5.4	(10.7)	2.8	(5.6)	FB
110054	-	97	-	-	-	-	-	97	100	--	(--)	--	(--)	--	(--)	
110057	(c)	(c)	(c)	(c)	(c)	(c)	(c)	(c)	100	30.5	(7.3)	17.5	(35.0)	28.5	(57.0)	B
110073	-	150	-	-	-	-	-	150	100	Self-Contained						
110139	23	87	-	-	-	-	-	110	100	--	(--)	--	(--)	--	(--)	
Average of 100 percent corrugated furnish mills (w/o self-contained mills)										8.8	(2.1)	11.2	(22.4)	8.5	(17.0)	
BPT Raw Waste Load										30.0	(7.2)	23.0	(46.0)	11.0	(21.9)	
Average of 100 percent corrugated furnish mills ≤BPT flow										4.6	(1.1)	9.6	(19.2)	4.5	(9.0)	
Average of 100 percent corrugated furnish mills ≤BPT BOD5										8.8	(2.1)	11.2	(22.4)	8.5	(17.0)	
Average of All Mills (w/o self-contained mills)										18.4	(4.4)	9.2	(18.4)	10.2	(20.3)	
Average of All Mills ≤BPT flow										13.4	(3.2)	8.7	(17.4)	8.3	(16.6)	

(a) A = Linerboard
B = Corrugating
C = Chip & Filter Board
D = Folding Board
E = Set-up Board
F = Gypsum Wallboard
G = Other Board Products
(b) F-Mills ≤BPT flow; B-Mills with ≤BPT BOD5.
(c) Production data held confidential.
(d) Production from 2 mills.
(e) Mill is now closed.
(f) Not included in averages of mills employing corrugating furnish as corrugating data were not provided by mill personnel.
(g) Mill self-contained through spray irrigation of mill effluent.

Attempts were made to determine if product mix has any affect on raw waste load characteristics. Two types of multiple regression analyses with one dependent variable were performed on the raw waste load data presented in Table V-16. No significant correlation was found to exist between raw waste levels and product type.

At 19 mills, no discharge of wastewater is practiced; these tend to be smaller mills, less than 190 kkg/day (210 tons/day), with slow-speed machines. All product types are being produced at self-contained mills. Table V-17 presents a summary of the method used in handling wastewater at each of the self-contained (zero discharge) mills.

Wastepaper-Molded Products. Table V-18 presents available data on wastewater discharge and BOD5 and TSS raw waste loadings for 15 mills representative of this subcategory. Various molded products are produced at these mills including food packs (e.g., meat display trays, egg cartons, and other containers of special design) and items such as molded sewer pipe and flower pots. These mills range in size from 2.5 kkg/day (2.8 tons/day) up to 169 kkg/day (186 tons/day) and have an average size of 44.2 kkg/day (48.7 tons/day). While these operations utilize primarily a wastepaper furnish, some grades also incorporate filler and sizing materials. Molding operations do not utilize Fourdrinier or cylinder papermachines, but employ forming machines on which several vacuum pick-up forming dies are located. The individual products are formed in one operation, pressed, and then dried.

Builders' Paper and Roofing Felt. Table V-19 presents available data on wastewater discharge and BOD5 and TSS raw waste loadings at 57 mills representative of this subcategory. At these mills, a variety of construction papers are produced, including roofing felt and shingles for the building trade. Both saturated and unsaturated papers are produced at mills in this subcategory. Generally, the asphalt saturation process utilizes a closed-cycle application system; saturating operations are also done at off-site converting plants.

A mixed wastepaper furnish is predominantly used. Generally, this is very low grade material, consisting of some corrugating and a great deal of mixed waste. At 23 of these mills, some coarse defibrator groundwood-type (TMP or other groundwood) pulps are produced on-site. This pulp is characterized by a yield of over 90 percent and is very coarse because there is little, if any, screening subsequent to the pulping step. Even at mills where groundwood pulps are produced, well over half of the total furnish is wastepaper.

No significant difference in the raw waste load characteristics are apparent between groups of mills where saturated and unsaturated papers are produced. The average BOD5 raw waste loading is higher at mills where TMP pulp is produced than at mills where essentially only wastepaper is utilized in the furnish. Where other groundwood pulps are produced on-site, lower average raw wastewater characteristics are exhibited than at mills where TMP/wastepaper or only wastepaper are used. These differences may not be as significant as indicated by the

TABLE V-17

METHODS OF WASTEWATER DISPOSAL AT SELF-CONTAINED PAPERBOARD FROM WASTEPAPER MILLS

Mill Number	Method of Handling Wastewater	Sludge Disposal
085002	Settling basins and sand filters with total recycle.	Unknown
110007	Rotating screen, 2 clarifiers, partial reuse of clarified wastewater, remainder to evaporation pond.	Landfill
110015	Savealls and screening of wastewater with total recycle.	Unknown
110016	Savealls with total recycle.	Unknown
110018	Settling basin with total recycle.	Unknown
110026	Savealls with total recycle.	Unknown
110033	Savealls with total recycle.	Unknown
110037	Screening, clarifier, and settling basin with total recycle.	Reused
110044	Saveall with partial recycle to process, primary clarifier treats remaining wastewater with more recycle, remaining wastewater (about 2%) treated by ASB with settling basin and evaporation.	Reused
110064	Saveall with total recycle.	Unknown
110073	Screen with total recycle. Emergency holding pond and recycle also available.	Landfill
110081	Saveall with total recycle. Emergency overflow to city sewer.	Unknown
110086	Screens, clarifier, settling basins, and clarifier with total recycle.	Landfill
110107	Clarifier with total recycle.	Landfill
110116	Unknown.	Unknown
110135	Clarifier with total recycle.	Unknown
110141	Clarifier with partial recycle, remainder flows to spray irrigation system.	Reused
110142	Saveall with total recycle. Can discharge to POTW when required.	Unknown
110146	Saveall with total recycle.	Unknown

TABLE V-18

SUMMARY RAW WASTE LOAD DATA
WASTEPAPER-MOLDED PRODUCTS SUBCATEGORY

	Production Profile			Raw Waste Load					
		Product		Flow		BOD5		TSS	
Mill No.	Furnish	(t/d)	Type	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
150002(a)(c)	WP	20.0	Pipe, Conduit	20.4	(4.9)	4.6	(9.2)	20.1	(40.1)
150004(c)	WP	2.8	Egg Cartons	74.7	(17.9)	--	(--)	--	(--)
150005(a)	WP	5.5	Containers	25.0	(6.0)	2.4	(4.7)	8.4	(16.7)
150006(c)	GWD, Pulp Substitute	43.7	Molded Products	46.3	(11.1)	10.4	(20.7)	18.9	(37.7)
150007	WP	(b)	Molded Products	89.7	(21.5)	15.9	(31.7)	23.7	(47.3)
150009(a)	News, GWD Substitute	(b)	Molded Products	18.8	(4.5)	--	(--)	0.5	(1.0)
150010(a)	News	60.0	Molded Products	31.3	(7.5)	9.4	(18.8)	15.0	(30.0)
150011	News, Blank, Purch GWD, K	(b)	Egg Cartons, Trays	71.4	(17.1)	10.5	(20.9)	23.4	(46.7)
150021	News, GWD, Peat Moss	16.6	Molded Products, Peat Moss	173.2	(41.5)	5.2	(10.4)	11.2	(22.3)
150022	Box Cuttings GWD Substitute	61.8	Molded Products	54.7	(13.1)	7.6	(15.2)	16.8	(33.6)
150023	GWD, BLK 9% WP	186.0	Molded Products	86.8	(20.8)	8.6	(17.2)	10.9	(21.7)
150024	K, GWD, 55% WP	93.4	Molded Products	85.1	(20.4)	5.1	(10.2)	12.8	(25.6)
150025	News	26.5	Molded Products	110.2	(26.4)	0.2	(0.4)	0.9	(1.8)
150028	K, GWD Substitute	11.0	Flower Pots	Self-contained					
150030	News	3.0	Molded Products	--	(--)	--	(--)	--	(--)
Average (w/o self-contained mill)				68.4	(16.4)	7.3	(14.5)	13.5	(27.0)
Average of Recycle Mills (w/o self-contained mill)				23.8	(5.7)	5.5	(10.9)	11.0	(22.0)
Average of Non-Recycle Mills (w/o self-contained mill)				88.1	(21.1)	7.9	(15.8)	14.8	(29.6)
BPT Raw Waste Load				88.1	(21.1)	7.9	(15.8)	14.8	(29.6)

(a) Mill recycles significant amount of process wastewater.
(b) Production data held confidential.
(c) Mill is closed.

TABLE V-19

SUMMARY RAW WASTE LOAD DATA
BUILDERS' PAPER AND ROOFING FELT SUBCATEGORY

Mill No.	Production Profile					Raw Waste Load						
	Furnish	Product		Finish(a)	Subgroup (b)	Flow		BOD5		TSS		BPT(e)
		(t/d)	Type			kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	
120001	WP, WF	32	Construction Paper	S	W	65.1	(15.6)	--	(--)	--	(--)	
120002	WP, WF, Rag	116	Construction Paper Roofing Felt	U	W	3.3	(0.8)	--	(--)	--	(--)	F
120003	WP, Chips	(d)	Construction Paper		T	8.3	(2.0)	--	(--)	--	(--)	F
120004	WP, Rags, GWD	69	Construction Paper	S	G	4.2	(1.0)	5.5	(10.9)	1.5	(2.9)	FB
120005	WP, GWD	170	Asbestos Felt Organic Felt	U	G	1.3	(0.3)	4.2	(8.3)	2.2	(4.3)	FB
120006	WP, GWD	123	Construction Paper	U	G	Self-Contained						
120007	WP, GWD	90	Construction Paper	S	G	Self-Contained						
120008	WP, WF	(d)	Construction Paper Roofing Felt	S	W	26.3	(6.3)	--	(--)	--	(--)	F
120009	WP, WF	40	Construction Paper	S	W	--	--	--	(--)	--	(--)	
120010	WP, WF	29	Construction Paper	S	W	28.8	(6.9)	2.1	(4.2)	2.3	(4.6)	FB
120011	WP, Chips	345	Construction Paper	S	T	7.5	(1.8)	12.8	(25.5)	5.1	(10.1)	FB
120012	WP, TMP	228	Construction Paper	S	T	2.9	(0.7)	8.9	(17.8)	2.9	(5.8)	FB
120013(f)	WP, Chips	97	Construction Paper	U	T	13.8	(3.3)	33.4	(66.8)	10.1	(20.2)	F
120014	WP, Baled Pulp	21	Construction Paper	U	W	--	--	--	(--)	--	(--)	
120015	WP, Chips	92	Construction Paper	U	T	5.0	(1.2)	11.2	(22.3)	4.1	(8.2)	FB
120016	WP, GWD	30	Roofing Felt	U	T	7.1	(1.7)	--	(--)	--	(--)	F
120017	WP, TMP	73	Roofing Felt	S	T	Self-Contained						
120018	WP, TMP	88	Roofing Felt	U	T	Self-Contained						
120019	WP, TMP	156	Roofing Felt	U	T	4.2	(1.0)	--	--	7.4	(14.7)	F
120020	WP, Chips, TMP	82	Roofing Felt	U	T	Self-Contained						
120021(c)	WP, GWD	172	Roofing Felt	U	T	48.4	(11.6)	281.2	(562.4)	33.4	(66.8)	
120022(f)	WP, WF, Rag	53	Construction Paper	U	W	12.5	(3.0)	5.1	(10.1)	8.0	(15.9)	FB
120023(f)	WP, Chips	75	Roofing Felt	U	T	19.2	(4.6)	--	(--)	--	(--)	F
120024	WP, TMP	126	Roofing Felt	U	T	2.1	(0.5)	3.4	(6.8)	2.4	(4.7)	FB
120025	WP, WF, Rag	44	Roofing Felt Construction Paper	U	W	9.6	(2.3)	24.0	(48.0)	71.6	(143.2)	F
120026	TMP, Chips	71	Construction Paper	S	T	Self-Contained						
120027	WP, GWD	20	Construction Paper	S	G	Self-Contained						
120028	WP, TMP	193	Roofing Felt	U	T	40.9	(9.8)	22.1	(44.2)	17.7	(35.4)	F
120029	WP, TMP	39	Roofing Felt	U	T	Self-Contained						
120030	WP, WF, Rag	28	Roofing Felt Construction Paper	S	W	5.8	(1.4)	2.2	(4.3)	6.9	(13.8)	FB
120031	TMP, Chips	167	Construction Paper	S	T	16.7	(4.0)	6.2	(12.4)	6.0	(12.0)	FB
120032(f)	WP, TMP	77	Construction Paper	U	T	43.4	(10.4)	25.7	(51.4)	40.9	(81.8)	F
120033	WP, TMP	60	Construction Paper	U	T	0.8	(0.2)	--	(--)	--	(--)	F
120034	WP, WF, Rag	30	Construction Paper	U	W	Self-Contained						

TABLE V-19 (Continued)

	Production Profile					Raw Waste Load						
		Product			Subgroup	Flow		BOD5		TSS		
Mill No.	Furnish	(t/d)	Type	Finish(a)	(b)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≤BPT(e)
120035(f)	WP, WF, Rag	71	Construction Paper Construction Felt	S	W	--	(--)	--	(--)	--	(--)	
120036	WP, WF, Rag	54	Construction Paper Construction Felt	S	W	--	(--)	--	(--)	--	(--)	
120037	WP, WF, Rag	49	Construction Paper Construction Felt	U	W	--	(--)	--	(--)	--	(--)	
120038	WP, WF, Rag	51	Construction Paper Construction Felt	S	W	5.4	(1.3)	--	(--)	--	(--)	F
120040(f)	WP, WF, Rag	44	Construction Paper	S	W	Self-Contained						
120041	(d)	(d)	Construction Paper	S	(d)	Self-Contained						
120042	WP, WF, Rag	55	Construction Paper	S	W	--	(--)	--	(--)	--	(--)	
120043	WP, WF, Rag	43	Construction Paper	S	W	4.6	(1.1)	--	(--)	--	(--)	F
120044	WP, WF, Rag	21	Construction Paper	S	W	--	(--)	--	(--)	--	(--)	
120045	WP, WF, Rag	36	Construction Paper	S	W	0.4	(0.1)	--	(--)	--	(--)	F
120046	WP, WF, Rag	72	Construction Paper	S	W	--	(--)	--	(--)	--	(--)	
120047	WP, WF, Rag	63	Construction Paper	U	W	4.6	(1.1)	--	(--)	--	(--)	F
120048	WP, WF, Rag	40	Construction Paper	S	W	Self-Contained						
120049	WP, WF	22	Construction Paper	S	W	--	(--)	--	(--)	--	(--)	
120050	WP, WF, Rag	55	Construction Paper	U	W	10.0	(2.4)	5.0	(9.9)	7.6	(15.2)	FB
120051	WF, Purch Pulp	60	Construction Paper	U	O	Self-Contained						
120052	WP, WF	39	Construction Paper	U	W	--	(--)	--	(--)	--	(--)	
120054	WP, WF	60	Builders Board	U	O	7.9	(1.9)	3.9	(7.7)	6.5	(13.0)	FB
120055	TMP, WF	334	Construction Paper	S	T	Self-Contained						
120056	WP, WF	242	Builders Board	S	O	Self-Contained						
120057	TMP, WP	125	Construction Paper		T	13.8	(3.3)	14.1	(28.2)	15.3	(30.5)	FB
120058	TMP, WP, Rag	118	Construction Paper	U	T	Self-Contained						
120059	TMP, WP	140	Builders Paper	U	T	Self-Contained						
Average (w/o self-contained mills)						8.3	(2.0)	5.6	(11.1)	6.3	(12.5)	
Average Subgroup W (w/o self-contained mills)						14.6	(3.5)	7.7	(15.3)	19.3	(38.5)	
Average Subgroup T (w/o self-contained mills)						13.4	(3.2)	15.3	(30.6)	11.2	(22.3)	
Average Subgroup G (w/o self-contained mills)						2.9	(0.7)	4.8	(9.6)	1.8	(3.6)	
BPT Raw Waste Load						60.0	(14.4)	17.5	(35.0)	35.0	(70.0)	
Average of Mills with ≤BPT flow (w/o self-contained mills)						11.3	(2.7)	11.2	(22.3)	12.1	(24.2)	
Average of Mills with ≤BPT BOD5 (w/o self-contained mills)						9.2	(2.2)	6.5	(13.0)	5.4	(10.8)	

(a) S = Saturated; U = Unsaturated.
(b) W = Predominantly wastepaper furnish.
T = Furnish includes TMP.
G = Furnish includes other types of groundwood.
O = Other furnish.
(c) Mill recycles significant amount of process wastewater. Not included in averages.
(d) Production data held confidential.
(e) F - mill with ≤BPT flow; B - mill with ≤ BPT BOD5.
(f) Mill is closed.

averages shown in Table V-19. While there are many mills in this subcategory, raw waste load data are available for a lower percentage of mills compared to other subcategories. Mills in each of the furnish groupings exhibit raw waste loadings significantly lower than those which formed the basis of BPT effluent limitations.

Final product quality requirements are less stringent compared to other paper or board products. Therefore, the opportunity exists for recycling wastewater and reusing sludge in the process. At 17 mills in the subcategory, no wastewater is discharged. At a total of eight of these mills, a furnish is used that is predominately TMP pulp, at three a furnish is used that is predominately groundwood pulp, at four a furnish is used that is predominately wastepaper, and at two a combination of wood flour, wastepaper, and purchased pulp is used. Table V-20 presents information on the method of handling of wastewater at self-contained mills.

Miscellaneous Secondary Fibers Mills. Available data on wastewater discharge and BOD_5 and TSS raw waste loadings at all remaining secondary fibers mills are presented in Table V-21. Generally, at these mills, processes are employed that are typical of two or more subcategories or unique processes are employed that are not characterized by the current subcategorization scheme.

Nonintegrated-Fine Papers. Data are available on 36 mills representative of the nonintegrated-fine papers subcategory. Table V-22 presents available data on wastewater discharge and BOD_5 and TSS raw waste loadings. Products include high-quality coated and uncoated printing, writing, and other business papers, and specialty items. The mills vary in size from 12 kkg/day (13 tons/day) to 987 kkg/day (1,088 tons/day). The number of machines in use varies widely from mill to mill; operating units are generally small.

Attempts were made to relate factors such as coated versus uncoated production and the production of cotton or specialty items to raw waste load parameters. As shown in Table V-22, the mills where fine papers are produced from cotton fibers tend to have considerably higher raw waste load characteristics in terms of flow and BOD_5. Wastewater discharge and BOD_5 raw waste loadings do not appear significantly different at mills where coated paper is produced compared to mills where uncoated paper is produced. Another major factor influencing raw waste characteristics is the frequency of "waste significant" grade changes at mills in this subcategory. Data are presented for overall subcategory averages comparing mills with different frequencies of waste significant grade changes: no grade changes, less than one per day, and more than one per day. A distinct correlation is seen, with wastewater discharge and BOD_5 raw waste loading generally increasing with the frequency of grade changes.

Nonintegrated-Tissue Papers. Available data on raw wastewater characteristics for 26 mills representative of this subcategory are shown in Table V-23. Both industrial and sanitary grades of tissue papers are made, primarily from purchased pulps. Some wastepaper and

TABLE V-20

METHODS OF WASTEWATER DISPOSAL AT SELF-CONTAINED BUILDERS' PAPER AND ROOFING FELT MILLS

Mill Number	Method of Handling Wastewater	Sludge Disposal
120006	White water recycle, remainder to evaporation ponds.	Unknown
120007	Screening, lagoon, clarifier, and irrigation with some recycle.	Lagoon
120017	Total recycle.	Unknown
120018	Clarifier and recycle with overflow to city sewer in cases of emergency.	Landfill
120020	Total recycle at time of 308 survey; now a direct discharge.	Unknown
120026	Clarifier and recycle.	Landfill
120027	Primary and biological treatment and recycle.	Unknown
120029	Primary and biological treatment and recycle.	Unknown
120034	Total recycle.	Unknown
120040(a)	Saveall, screening, settling pond, and recycle.	Landfill
120041	Saveall, screening, and recycle.	Landfill
120048	Saveall, screening, holding tank for process spill recycle, and evaporation pond.	Lagoon
120051	Neutralization, settling basin, and recycle.	Landfill
120055	Filtration and recycle.	Unknown
120056	Screening, clarifier, storage tank, and recycle.	Unknown
120058	Saveall, clarifier, saveall, and recycle.	Unknown
120059	Saveall and recycle.	Unknown

(a) Mill is closed.

TABLE V-21

SUMMARY RAW WASTE LOAD DATA
SECONDARY FIBERS MISCELLANEOUS MILLS

Mill	Production Profile		Raw Waste Load					
			Flow		BOD5		TSS	
No.	(t/d)	Product	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
080002	20	Groundwood Specialties	--	(--)	--	(--)	--	(--)
110042(a)	240	Gypsum Board, Roofing Felt	35.9	(8.6)	--	(--)	--	(--)
110080(b)	536	San Tissue, Linerboard, Corrugating	28.0	(6.7)	--	(--)	--	(--)
110122	(c)	Electrical Insulation and Fiberboard	--	(--)	--	(--)	--	(--)
110109	533	Foldingboard, Wetlap Pulp	35.5	(8.5)	25.0	(50.0)	91.2	(182.4)
110132	275	San Tissue, Linerboard, Corrugating	33.4	(8.0)	9.0	(18.0)	17.3	(34.6)
110136	61	Chip & Filler Board, Tube Stock GWD Specialty, Pressboard, Other Board	--	(--)	--	(--)	--	(--)
120039	350	Gypsum Wall Board, Construction Paper	14.2	(3.4)	34.3	(68.6)	15.7	(31.4)
140004	72	Sanitary Tissue	34.6	(8.3)	--	(--)	3.4	(6.7)
140006	161	Fine, Specialties	102.7	(24.6)	22.0	(44.0)	88.5	(176.9)
140009	138	Sanitary Tissue	55.1	(13.2)	13.7	(27.3)	46.9	(93.8)
140012	304	Uncoated Fine Paper	34.2	(8.2)	--	(--)	53.9	(107.8)
140016	(c)	Market Deink	8.3	(2.0)	34.6	(69.2)	68.8	(137.6)
140020	278	Uncoated Fine Paper	98.9	(23.7)	--	(--)	70.9	(141.7)
140023	98	Unctd Fine & GWD, GWD Specialties	99.3	(23.8)	14.5	(28.9)	27.6	(55.1)
140026	319	Coated, Uncoated Fine	92.2	(22.1)	38.4	(76.8)	105.9	(211.8)
140027	201	Uncoated Fine	56.3	(13.5)	29.0	(58.0)	105.0	(210.0)
150008	44	Cotton Fiber, Specialties	45.5	(10.9)	3.5	(7.0)	7.6	(15.2)

(a) Data is primary treatment effluent.
(b) Data is representative of secondary fibers miscellaneous operation; since data collection, the mill has discontinued tissue production and is now classified as a paperboard from wastepaper mill.
(c) Production data held confidential.

TABLE V-22

SUMMARY RAW WASTE LOAD DATA
NONINTEGRATED-FINE PAPERS SUBCATEGORY

Mill Number	Production Profile: Percent Cotton Furnish	Production Profile: (t/d)	Production Profile: Product	Grade Change /Day(a)	Raw Waste Load: Flow kl/kkg	Flow (kgal/ton)	BOD5 kg/kkg	BOD5 (lb/ton)	TSS kg/kkg	TSS (lb/ton)	≤BPT(b)
Wood Fiber Furnish											
080001	0	(c)	Unctd Print	+	26.7	(6.4)	9.0	(17.9)	14.0	(27.9)	FB
080005	1.5	63	Print, Thin, Cotton	+	35.1	(8.4)	--	(--)	--	(--)	F
080007(d)	0	165	Unctd Print	0	68.9	(16.5)	6.9	(12.8)	19.8	(39.6)	
080009	0	1088	Ctd & Unctd Print	+	76.8	(18.4)	5.9	(11.8)	25.0	(50.0)	B
080017	0	125	Ctd Print	0	------------	------------	-Self-Contained-	------------	------------	------------	
080018	0	135	Unctd Print	0	24.6	(5.9)	--	(--)	--	(--)	F
080019	0	54	Unctd Print	-	17.9	(4.3)	--	(--)	--	(--)	F
080027	0	381	Ctd & Unctd Print	-	38.0	(9.1)	13.7	(27.3)	40.7	(81.3)	F
080028	0	81	Unctd Print	-	82.6	(19.8)	--	(--)	44.7	(89.3)	
080029	1.7	116	Print, Write, Ind Conv. Cotton	-	45.9	(11.0)	--	(--)	--	(--)	F
080030	0	74	Unctd Print	+	22.5	(5.4)	--	(--)	--	(--)	F
080031	0	(c)	Unctd Print	+	43.0	(10.3)	--	(--)	--	(--)	F
080033	0	15	Unctd	+	96.8	(23.2)	25.6	(51.2)	85.0	(170.0)	
080034	0	(c)	Unctd	-	25.9	(6.2)	5.8	(11.5)	10.2	(20.4)	FB
080037	0	742	Ctd Print, Board	0	21.7	(5.2)	7.7	(15.4)	17.0	(34.0)	FB
080038	0	(c)	Ctd & Unctd Print	0	44.7	(10.7)	10.5	(20.9)	43.5	(87.0)	FB
080040	0	587	Ctd Print	-	86.0	(20.6)	16.9	(33.8)	115.2	(230.3)	
080041	0	412	Print, Write, Pkg	-	110.6	(26.5)	14.9	(29.8)	47.8	(95.5)	
080045	0.8	144	Unctd Print	-	33.0	(7.9)	10.8	(21.6)	41.8	(83.6)	F
080046	0	455	Unctd Print	-	61.3	(14.7)	13.8	(27.6)	31.5	(62.9)	F
080047	0	191	Unctd Print	0	11.7	(2.8)	3.3	(6.5)	4.5	(8.9)	FB
080048	0	173	Unctd Print	+	50.5	(12.1)	11.1	(22.1)	18.3	(36.5)	F
080049	0	(c)	Unctd Print	+	48.4	(11.6)	--	(--)	--	(--)	F
080051	0	35	Unctd Print	0	73.9	(17.7)	--	(--)	--	(--)	
080053	0	267	Unctd Print	-	53.0	(12.7)	3.8	(7.6)	24.4	(48.8)	FB
080055	0	(c)	Unctd Print, Sat	0	54.2	(13.0)	--	(--)	--	(--	F
105021	0	115	Ctd Print, Electrical	-	71.4	(17.1)	--	(--)	--	(--)	
105036	0	(c)	Base Stock, Thin	-	--	(--)	--	(--)	--	(--)	
105047	0	103	Ctd Pkg	0	79.7	(19.1)	--	(--)	18.3	(36.6)	
Average (w/o self-contained mill)					52.2	(12.5)	10.9	(21.8)	35.4	(70.7)	
Average - no grade change					48.4	(11.6)	7.7	(15.4)	18.4	(36.8)	
Average - <1 grade change/day					56.8	(13.6)	11.4	(22.7)	44.5	(89.0)	
Average - >1 grade change/day					50.1	(12.0)	12.9	(25.8)	35.6	(71.1)	
BPT Raw Waste Load					63.0	(15.2)	10.8	(21.5)	30.8	(61.6)	
Average ≤BPT Flow - no grade changes					38.0	(9.1)	7.7	(15.4)	17.0	(34.0)	
Average ≤BPT BOD5 - no grade changes					21.7	(5.2)	7.7	(15.4)	17.0	(34.0)	
Average ≤BPT Flow - <1 grade change/day					39.2	(9.4)	9.6	(19.1)	29.7	(59.4)	

TABLE V-22 (Continued)

Mill Number	Production Profile: Percent Cotton Furnish	(t/d)	Product	Grade Change /Day(a)	Raw Waste Load: Flow kl/kkg	Flow (kgal/ton)	BOD5 kg/kkg	BOD5 (lb/ton)	TSS kg/kkg	TSS (lb/ton)	≤BPT(b)
Average ≤BPT BOD5 - <1 grade change/day					39.6	(9.5)	4.8	(9.6)	17.3	(34.6)	
Average ≤BPT Flow - >1 grade change/day					37.6	(9.0)	10.0	(20.0)	16.1	(32.2)	
Average ≤BPT BOD5 - >1 grade change/day					51.7	(12.4)	7.5	(14.9)	19.5	(39.0)	
Cotton Fiber Furnish											
080003	24.0	25	Cotton	U	149.4	(35.8)	6.0	(12.0)	7.0	(14.0)	FB
080004	26.0	13	Cotton	U	88.9	(21.3)	17.9	(35.7)	65.0	(130.0)	FB
080032	4.3	(c)	Unctd Rag	+	118.1	(28.3)	12.1	(24.2)	29.4	(58.7)	FB
080042	5.0	43	Unctd Cotton,Carbon	U	78.9	(18.9)	19.5	(39.0)	44.8	(89.6)	FB
080043	15.0	30	Unctd Print,Artist,Cotton	+	269.2	(64.5)	40.7	(81.4)	86.5	(173.0)	
080044	16.1	71	Unctd Print Cotton	+	141.9	(34.0)	15.9	(31.7)	49.7	(99.4)	FB
080050	16.7	33	Unctd Print Cotton	U	25.5	(6.1)	13.7	(27.3)	15.2	(30.3)	FB
Average					124.4	(29.8)	18.0	(35.9)	42.5	(85.0)	
Averge - > 1 grade change/day					176.5	(42.3)	22.9	(45.8)	55.2	(110.4)	
BPT Raw Waste Load					176.5	(42.3)	22.9	(45.8)	55.2	(110.4)	
Average of Mills ≤BPT Flow and ≤ BPT BOD5- >1 grade change/day					130.2	(31.2)	14.0	(28.0)	39.6	(79.1)	

(a) - = <1; + = >1; U = unknown.
(b) F-Mill with ≤BPT flow; B-Mill with ≤BPT BOD5.
(c) Production data held confidential.
(d) Raw waste load BOD5 data after primary treatment; BOD5 data are not included in averages.

TABLE V-23

SUMMARY RAW WASTE LOAD DATA
NONINTEGRATED-TISSUE PAPERS SUBCATEGORY

	Production Profile							Raw Waste Load						
	Furnish				Product			Flow		BOD5		TSS		
Mill No.	Purch	GWD	DI	WP	(t/d)	Type	Grade Change/Day(a)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	≤BPT(b)
090001	23	--	--	5	20	Industrial Tissue	0	104.3	(25.0)	4.5	(9.0)	5.0	(10.0)	B
090005(e)	(c)	(c)	(c)	(c)	(c)	Sanitary Tissue	0	23.0	(5.5)	5.6	(11.2)	11.5	(22.9)	FB
090007	(c)	(c)	(c)	(c)	(c)	Sanitary Tissue	-	78.0	(18.7)	8.0	(15.9)	28.5	(57.0)	FB
090008	(c)	(c)	(c)	(c)	(c)	Sanitary Tissue	0	96.8	(23.2)	15.3	(30.6)	47.1	(94.2)	
090009	(c)	(c)	(c)	(c)	(c)	Sanitary Tissue	-	89.7	(21.5)	9.9	(19.7)	25.7	(51.4)	FB
090011(e)	62	--	--	12	70	Sanitary Tissue	-	78.9	(18.9)	--	(--)	--	(--)	F
090012	62	--	--	--	59	Sanitary Tissue	-/w	35.9	(8.6)	--	(--)	--	(--)	F
090013(d)	34	1	--	3	37	Sanitary Tissue	U	63.8	(15.3)	6.3	(12.6)	40.0	(80.0)	F
090016	(c)	(c)	(c)	(c)	(c)	Sanitary Tissue	U	56.8	(13.6)	18.0	(36.0)	53.2	(106.4)	F
090017	(c)	(c)	(c)	(c)	(c)	Sanitary Tissue	-/w	56.3	(13.5)	14.9	(29.7)	48.3	(96.5)	F
090018(e)	(c)	(c)	(c)	(c)	(c)	Sanitary Tissue	-	80.1	(19.2)	12.8	(25.6)	43.9	(87.8)	F
090019	139	19	--	48	159	Sanitary Tissue	U	103.5	(24.8)	--	(--)	--	(--)	
090020	887	57	--	5	890	Sanitary Tissue	+	79.7	(19.1)	22.9	(45.7)	54.5	(108.9)	F
090021	119	11	--	40	176	Mixed Product	+	170.7	(40.9)	--	(--)	31.2	(62.3)	
090022	154	7	--	--	189	Mixed Product	-	66.8	(16.0)	9.1	(18.2)	26.9	(53.7)	FB
090023	(c)	(c)	(c)	(c)	(c)	Mixed Product	-/w	30.9	(7.4)	--	(--)	15.8	(31.5)	F
090024	(c)	(c)	(c)	(c)	(c)	Sanitary Tissue	0	--	(--)	--	(--)	--	(--)	
090025	6	--	--	--	6	Mixed Product	-	286.7	(68.7)	14.6	(29.1)	14.6	(29.1)	
090026	21	--	5	28	50	Sanitary Tissue	U	74.7	(17.9)	17.4	(34.8)	53.8	(107.6)	F
090027	140	--	--	--	140	Sanitary Tissue	0	17.9	(4.3)	0.7	(1.3)	4.1	(8.2)	FB
090028(d)(e)	(c)	(c)	(c)	(c)	(c)	Sanitary Tissue	U	143.6	(34.4)	--	(--)	--	(--)	
090029	41	--	--	14	44	Industrial Tissue	0	94.7	(22.7)	--	(--)	--	(--)	F
090030	(c)	(c)	(c)	(c)	(c)	Sanitary Tissue	0	32.5	(7.8)	1.7	(3.3)	6.6	(13.1)	FB
090031	14	--	--	4	17	Mixed Product	-/W	98.1	(23.5)	--	(--)	--	(--)	
090032	26	--	--	4	27	Mixed Product	-	177.8	(42.6)	--	(--)	--	(--)	
090033	15	--	--	1	14	Mixed Product	0	29.6	(7.1)	1.0	(2.0)	5.8	(11.5)	FB
Average								85.5	(20.5)	10.4	(20.8)	28.0	(56.0)	
Average - Industrial Tissue Only								99.7	(23.9)	4.5	(9.0)	5.0	(10.0)	
Average - no grade changes								57.2	(13.7)	4.8	(9.6)	13.4	(26.7)	
Average - <1 grade change/week								55.5	(13.3)	14.9	(29.7)	32.0	(64.0)	
Average - <1 grade change/day								122.7	(29.4)	10.9	(21.7)	27.9	(55.8)	
Average - >1 grade change/day								125.2	(30.0)	22.9	(45.7)	42.8	(85.6)	
BPT Raw Waste Load								96.0	(22.9)	11.5	(22.9)	34.7	(69.4)	
Average of Mills with ≤BPT flow - No grade changes								39.6	(9.5)	2.3	(4.5)	7.0	(13.9)	
Average of Mills with ≤BPT BOD5 - No grade changes								41.3	(9.9)	2.7	(5.4)	6.6	(13.1)	
Average of Mills with ≤BPT flow - <1 grade change/week								40.9	(9.8)	14.9	(29.7)	32.0	(64.0)	
Average of Mills with ≤BPT BOD5 - <1 grade change/week								--	(--)	--	(--)	--	(--)	
Average of Mills with ≤BPT flow - <1 grade change/day								78.9	(18.9)	10.0	(19.9)	31.3	(62.5)	
Average of Mills with ≤BPT BOD5 - <1 grade change/day								78.0	(18.7)	9.0	(17.9)	27.0	(54.0)	
Average of Mills with ≤BPT flow - >1 grade change/day								79.7	(19.1)	22.9	(45.7)	54.5	(108.9)	
Average of Mills with ≤BPT BOD5 - >1 grade change/day								--	(--)	--	(--)	--	(--)	

(a) - = <1; -/w = <1/week; U = unknown.
(b) F-Mill with ≤BPT flow; B-Mill with ≤BPT BOD5.
(c) Production data held confidential.
(d) Flow, BOD5 and TSS data not included in averages because they do not represent a true raw waste load.
(e) Mill is now closed.

purchased deink and groundwood pulps are also used in the manufacturing operations.

As with the nonintegrated-fine papers subcategory, the major factor influencing raw waste loadings is the frequency of waste significant grade changes. In general, wastewater discharge and BOD_5 raw waste loadings increase with the frequency of grade changes. Insufficient data are available on the production of industrial tissue grades to determine if there are significant differences in raw waste loads due to differences in the type of products manufactured.

Nonintegrated-Lightweight Papers. Available data on raw wastewater characteristics for 17 mills that are representative of this subcategory are presented in Table V-24. Lightweight, thin, tissue, and electrical papers are produced at mills in this subcategory. EPA attempted to group mills based on product type as illustrated in Table V-24. Differences between these groups are minor with one exception. At those mills where electrical papers are produced, larger quantities of water are discharged than at mills where non-electrical lightweight grades are produced.

As with the nonintegrated-fine papers and nonintegrated-tissue papers subcategories, the major factor influencing raw waste loadings is the frequency of waste significant grade changes. Wastewater discharge and BOD_5 raw waste loadings generally increase with the frequency of grade changes.

Nonintegrated-Filter and Nonwoven Papers. Available data on raw wastewater characteristics for 14 mills representative of this subcategory are presented in Table V-25. Average production is 15 kkg/day (16 tons/day). At these mills, a wide variety of filter and nonwoven papers are produced such as open-blotting type papers, hand sheet testing blotters, oil and air filter papers (often saturated with resins), vacuum cleaner bags, and a growing variety of nonwoven type papers for personal, sanitary, and disposal uses.

As with the other subcategories in the nonintegrated segment of the pulp, paper, and paperboard industry, the major factor influencing raw waste loadings is the frequency of waste significant grade changes. In general, wastewater discharge and BOD_5 raw waste loadings increase with the frequency of grade changes.

Nonintegrated-Paperboard. Available data on raw wastewater characteristics for 11 mills that are representative of this subcategory are presented in Table V-26. Major products manufactured at mills in the nonintegrated-paperboard subcategory include electrical board, matrix board (used for typesetting), food board, press board, and other board products. As shown in Table V-26, larger quantities of wastewater are discharged at mills where electrical grades or matrix board are produced. However, there is an inadequate data base on which to characterize mills where electrical board or matrix board are made.

TABLE V-24

SUMMARY RAW WASTE LOAD DATA
NONINTEGRATED-LIGHTWEIGHT PAPERS SUBCATEGORY

	Profile Profile						Raw Waste Load					
	Furnish (t/d)				Product	Grade	Flow		BOD5		TSS	
Mill No.	Purch	WP	Misc	Broke	(t/d)	Change/Day(a)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Electrical Paper												
105003(f)	11.2	--	--	--	11.2	-	446.9	(107.1)	--	(--)	--	(--)
105015	(b)	(b)	(b)	(b)	(b)	0	313.0	(75.0)	--	(--)	--	(--)
105017	(b)	(b)	(b)	(b)	(b)	0	269.2	(64.5)	--	(--)	--	(--)
105018(c)	(b)	(b)	(b)	(b)	(b)	0	755.3	(181.0)	--	(--)	--	(--)
105071	26.0	--	--	--	26.3	U	254.1	(60.9)	11.4	(22.8)	19.1	(38.1)
Average							320.9	(76.9)	11.4	(22.8)	19.1	(38.1)
Miscellaneous Tissue and Carbonized												
090015	47.4	25.6	--	--	64.2	+	224.9	(53.9)	57.7	(115.3)	149.9	(299.8)
105057	33.0	5.1	--	--	34.0	0	147.3	(35.3)	2.9	(5.7)	5.2	(10.3)
105058	34.0	4.9	--	--	35.0	-	208.7	(50.0)	11.8	(23.6)	25.7	(51.4)
Average							193.6	(46.4)	24.1	(48.2)	60.3	(120.5)
Printing & Thin Paper												
080039(f)	(b)	(b)	(b)	(b)	(b)	+	236.6	(56.7)	29.4	(58.8)	127.1	(254.2)
105014	(b)	(b)	(b)	(b)	(b)	-	170.7	(40.9)	--	(--)	--	(--)
105020	203.0	4.0	2.0	--	203.0	-	202.4	(48.5)	8.3	(16.5)	15.6	(31.1)
Average							203.2	(48.7)	18.9	(37.7)	71.4	(142.7)
Carbonized, Thin, Cigarette - Less Wastepaper												
080024	29.6	--	--	5.3	32.5	0	60.3	(14.3)	--	(--)	--	(--)
080021(d)	30.3	--	--	--	26.9	0	10.8	(2.6)	0.2	(0.3)	0.1	(0.2)
080022	102.4	11.3	--	--	110.5	-	--	(--)	--	(--)	--	(--)
090003	12.0	1.6	--	4.4(e)	18.0	-	128.9	(30.9)	--	(--)	--	(--)
105013	15.1	--	5.3	--	20.4	-	135.2	(32.4)	19.9	(39.7)	57.0	(114.0)
105016	(b)	(b)	(b)	(b)	(b)	-	517.5	(124.0)	--	(--)	--	(--)
Average							210.7	(50.5)	19.9	(39.7)	57.0	(114.0)
Average of All Mills							237.0	(56.8)	20.2	(40.3)	57.1	(114.1)
Average of Electrical							320.9	(76.9)	11.4	(22.8)	19.1	(38.1)
Average w/o Electrical							203.2	(48.7)	21.7	(43.3)	63.4	(126.8)
Average of mills - no grade change and flow ≤ the Average w/o Electrical							103.9	(24.9)	2.9	(5.7)	5.2.	(10.3)
Average of mills - no grade change and BOD5 ≤ the Average w/o Electrical							147.3	(35.3)	2.9	(5.7)	5.2	(10.3)
Average of mills - <1 grade change/day and flow ≤ the Average w/o Electrical							159.4	(38.2)	14.1	(28.1)	36.3	(72.6)
Average of mills - <1 grade change per day and BOD5 ≤ to the Average w/o Electrical							181.9	(43.6)	13.3	(26.6)	32.8	(65.5)
Average of Electrical mills - flow ≤ the Average of Electrical							278.8	(66.8)	11.4	(22.8)	19.1	(38.1)

(a) - = <1; + = >1; U = unknown.
(b) Production data held confidential.
(c) Represents a combination of process sewer and a very high flow from a thermal sewer. Apparently, mill must use high flow on thermal sewer to meet thermal discharge limits. Not included in averages.
(d) After primary clarification; not included in average.
(e) Estimated to balance.
(f) Mill is now closed.

TABLE V-25

SUMMARY RAW WASTE LOAD DATA
NONINTEGRATED-FILTER AND NONWOVEN PAPERS SUBCATEGORY

	Production Profile			Raw Waste Load					
	Product		Grade	Flow		BOD5		TSS	
Mill No.	(t/d)	Type	Change/Day(a)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
105005	5.9	Saturated Filter & Nonwoven	-	328.8	(78.8)	--	(--)	24.3	(48.6)
105029	4.1	Technical & Filter	U	144.0	(34.5)	18.2	(36.4)	14.7	(29.3)
105030	(b)	Filter	0	189.9	(45.5)	--	(--)	--	(--)
105031	0.7	Filter	0	394.3	(94.5)	--	(--)	--	(--)
105033	(b)	Filter, Wall Cover Miscellaneous	+	224.1	(53.7)	--	(--)	--	(--)
105034	(b)	Filter	+	172.3	(41.3)	--	(--)	--	(--)
105043	(b)	Filter, Blotting, Photo	+	280.4	(67.2)	25.0	(49.9)	54.6	(109.5)
105044	(b)	Filter, Blotting, Pkg	0	25.9	(6.2)	3.8	(7.5)	12.8	(25.5)
105045	(b)	Filter, Pkg	U	40.1	(9.6)	--	(--)	--	(--)
105051	(b)	Filter, Sat Tech	-	171.1	(41.0)	5.0	(9.9)	19.4	(38.8)
105052	(b)	Filter	0	17.9	(4.3)	--	(--)	--	(--)
105053	(b)	Filter	0	42.6	(10.2)	--	(--)	--	(--)
105054	(b)	Filter, Photo, Wrap	U	6.7	(1.6)	--	(--)	--	(--)
105055	(b)	Filter, Saturated	+	288.4	(69.1)	9.0	(17.9)	38.3	(76.5)
Average of All Mills				166.1	(39.8)	12.2	(24.3)	27.4	(54.7)
Average of mills - no grade change				134.0	(32.1)	3.8	(7.5)	12.8	(25.5)
Average of mills - <1 grade change/day				250.0	(59.9)	5.0	(9.9)	21.9	(43.7)
Average of mills - >1 grade change/day				241.2	(57.8)	17.0	(33.9)	46.5	(93.0)
Average of Mills - no grade change and flow ≤ the Average of Mills with <1 grade change/day				69.3	(16.6)	3.8	(7.5)	12.8	(25.5)
Average of Mills - no grade changes and BOD5 ≤ the Average of All Mills				25.9	(6.2)	3.8	(7.5)	12.8	(25.5)
Average of Mills - <1 grade change/day and BOD5 ≤ the Average of All Mills and flow ≤ the Average of All Mills with <1 grade change/day				171.1	(41.0)	5.0	(9.9)	19.4	(38.8)
Average of Mills->1 grade change/day and flow ≤ the Average of Mills with <1 grade change/day				198.2	(47.5)	--	(--)	--	(--)
Average of Mills >1 one grade change/day and BOD5 ≤ the Average of All Mills				288.4	(69.1)	9.0	(17.9)	38.3	(76.5)

(a) - = <1; + = >1; U + Unknown.
(b) Production data held confidential.

TABLE V-26

SUMMARY RAW WASTE LOAD DATA
NONINTEGRATED-PAPERBOARD SUBCATEGORY

	Production Profile					Raw Waste Load					
	Furnish(t/d)		Product		Grade	Flow		BOD5		TSS	
Mill No.	Purch	WP	(t/d)	Type	Change/Day(a)	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
085001	60.0	12	84.0	Packaging, Bag	+	29.6	(7.1)	--	(--)	--	(--)
085007	(b)	(b)	(b)	Matrix Board	U	184.9	(44.3)	--	(--)	--	(--)
085008	32.0	22	50.0	Pkg, Bag, Specialty	U	62.6	(15.0)	10.0	(20.0)	25.0	(50.0)
085010	(b)	(b)	(b)	Matrix Board	U	168.2	(40.3)	7.0	(13.9)	46.4	(92.7)
105001	33.5	--	38.2	Food Board, Gift	O	30.0	(7.2)	8.2	(16.4)	43.2	(86.4)
105002	9.2	--	8.4	Hi Dens Electrical	U	273.3	(65.5)	--	(--)	--	(--)
105039	(b)	(b)	(b)	Latex, Sat Gaskets	-	48.8	(11.7)	--	(--)	--	(--)
105048	46.0	--	62.0	Impregnated Fiber	-	38.8	(9.3)	--	(--)	--	(--)
105049	44.0	--	51.0	Impregnated Fiber	-	53.0	(12.7)	--	(--)	--	(--)
105070	(b)	(b)	(b)	Electrical Board	U	221.6	(53.1)	87.5	(175.0)	136.5	(272.9)
105073	17.1	--	15.0	Saturated Paper for Vulcanizing	U	105.6	(25.3)	13.0	(26.0)	42.4	(84.7)
110021	47.4	36.6	76.0	Press Board	U	63.0	(15.1)	--	(--)	--	(--)
Average						106.8	(25.6)	25.2	(50.3)	58.7	(117.3)
Average w/o Electrical						78.5	(18.8)	9.6	(19.1)	39.3	(78.5)
Average w/o Electrical or Matrix						53.8	(12.9)	10.4	(20.8)	36.9	(73.7)
Average of Mills - no grade change and flow ≤ the Average w/o Electrical or Matrix						30.0	(7.2)	8.2	(16.4)	43.2	(86.4)
Average of Mills - no grade change and BOD5 ≤ the Average w/o Electrical or Matrix						30.0	(7.2)	8.2	(16.4)	43.2	(86.4)
Average of Mills - <1 grade change/day and flow ≤ the Average w/o Electrical or Matrix						46.7	(11.2)	--	(--)	--	(--)
Average of Mills - <1 grade change/day and BOD5 ≤ the Average w/o Electrical or Matrix						--	(--)	--	(--)	--	(--)
Average of Mills - >1 grade change/day and flow ≤ Average w/o Electrical or Matrix						29.6	(7.1)	--	(--)	--	(--)
Average of Mills - >1 grade change/day and BOD5 ≤ the Average w/o Electrical or Matrix						--	(--)	--	(--)	--	(--)

(a) - = <1; + = >1; U = Unknown.
(b) Production data held confidential.

EPA attempted to evaluate data on wastewater discharge and BOD5 waste loadings as a function of the number of waste significant grade changes per day. The data base is very limited and no correlation was apparent between frequency of grade change and raw waste characteristics.

Miscellaneous Nonintegrated Mills. Table V-27 presents available data on wastewater discharge and BOD5 and TSS raw waste loadings for all remaining nonintegrated mills. At these mills, products representative of two or more subcategories or unique products not defined by the current subcategorization scheme are manufactured.

TOXIC AND NONCONVENTIONAL POLLUTANTS

Screening Program

As part of the overall project investigations, a screening program was undertaken to provide information on the presence or absence and the relative levels of toxic and nonconventional pollutants discharged at mills in the pulp, paper, and paperboard industry. As explained in Section II, screening was a three-phase effort. The first phase was the initial screening conducted by the contractor covering 11 of the 15 mill groupings established as representative of the pulp, paper, and paperboard industry. The second phase included screening at 17 of the verification program mills where processes were employed that were characteristic of the four mill groupings not included in the initial screening program. The third phase involved 47 screening surveys conducted by EPA Regional Surveillance and Analysis (S&A) field teams. Collection and analysis of screening samples collected at the 17 verification mills and at the 47 mills sampled by Regional S&A field teams adhered to the procedures specified in Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants (EPA, Cincinnati, Ohio, April, 1977).(15)

Table V-28 presents a summary of the data collected during these 11 screening survey programs. A summary of the analysis results for the second phase of the screening program conducted by the contractor at the 17 verification mills is presented in Table V-29. The results shown in Table V-29 are for only those compounds that were not detected in any wastewater samples taken at the 11 mills sampled during initial screening surveys.

Table V-30 presents a summary of the analysis results for the 42 regional surveys for which data are available. At 31 of the 47 facilities surveyed by the Regional S&A teams, 3 individual 24-hour composite samples were collected and analyzed rather than a single 72-hour composite. Analysis results for the screening surveys conducted by the Regional S&A teams are in general agreement with those conducted by the Agency contractor.

TABLE V-27

SUMMARY RAW WASTE LOAD DATA
NONINTEGRATED MISCELLANEOUS MILLS

Mill No.	Production Profile Production (t/d)	Product	Raw Waste Load Flow kl/kkg	(kgal/t)	BOD kg/kkg	(lb/t)	TSS kg/kkg	(lb/t)
080006	(a)	Print, Photo	43.4	(10.4)	4.1	(8.1)	34.7	(69.4)
080008	248	Print, Cotton, Pkg, Tissue	1.7	(0.4)est	--	(--)	1.0	(1.9)
080026	(a)	Print, Photo, Cotton, Specialty Pkg	----------Self-Contained----------					
080036	(a)	Print, Thin, Tissue, Release Base	53.0	(12.7)	8.0	(15.9)	17.5	(35.0)
085005	(a)	Pkg, Conv	63.4	(15.2)	4.4	(8.7)	18.1	(36.2)
105004	(a)	Spec Pkg, Glassine	116.0	(27.8)	--	(--)	--	(--)
105008	262	Print, Tech, Gasket, Sat	--	(--)	--	(--)	--	(--)
105010	(a)	Spec Pkg, Sat	83.5	(20.0)	36.7	(73.3)	--	(--)
105011	12	Spec Pkg, Glassine, Grease Prf	--	(--)	--	(--)	--	(--)
105012	45	Spec Pkg, Glassine, Grease Prf	--	(--)	--	(--)	--	(--)
105019	(a)	Print, Write, Tape, Sat Gasket	96.4	(23.1)est	--	(--)	--	(--)
105022	(a)	Unctd, Bristol, Pkg	122.3	(29.3)	16.5	(32.9)	29.2	(58.4)
105023	(a)	Spec Pkg, Auto, Separated	170.3	(40.8)	10.2	(20.4)	15.7	(31.3)
105024	(a)	Print, Pkg, Wet Str Glassine	159.8	(38.3)	4.5	(9.0)	25.5	(51.0)
105026	(a)	Print, Poster, Ind Conv Pkg, Sat	108.5	(26.0)	10.5	(20.9)	17.0	(33.9)
105027	27	Pkg	122.3	(29.3)	14.7	(29.3)	40.3	(80.6)
105028	77	Print, Tech, Pkg, Sat, Surgical	59.3	(14.2)	8.1	(16.1)	24.1	(48.2)
105032	33	Gasket, Latex Sat	31.3	(7.5)est	3.4	(6.8)est	25.8	(51.5)
105035	(a)	Asbestos, Gasket, Insul	164.0	(39.3)	--	(--)	30.2	(60.4)
105037	43	Pkg, Ind Conv	89.3	(21.4)	2.0	(4.0)	3.0	(6.0)
105038	50	Pkg, Ind Conv	125.2	(30.0)	10.0	(20.0)	--	(--)
105040	(a)	Pkg, Ind Conv, Sat, Bag	127.7	(30.6)	13.6	(27.1)	61.7	(123.3)
105041	(a)	Bristol, Cable, Index, Gasket	--	(--)	--	(--)	--	(--)
105042	(a)	Copybase, Release, Specialty	106.4	(25.5)	14.4	(28.7)	50.6	(101.1)
105050	(a)	Tape, Spec, Panels	184.0	(44.1)	17.4	(34.8)	41.1	(82.2)
105056	(a)	Print, Thin, Pkg, Sat, Tissue	160.2	(38.4)	6.9	(13.8)	13.8	(27.6)
105059	153	Print, Ctd, Release, Spec	44.2	(10.6)	8.3	(16.5)	34.0	(68.0)
105061	409	Pkg, Print	53.0	(12.7)	6.5	(12.9)	48.8	(97.6)
105062(b)	36	Parchment	--	(--)	--	(--)	--	(--)
105065	57	Print, Pkg, Cover, Masking	110.2	(26.4)	--	(--)	--	(--)
105066	(a)	Tech, Asbestos, Pkg	223.3	(53.5)	4.3	(8.6)	156.5	(312.9)
105067	(a)	Tech, Pkg, Lightweight	222.8	(53.4)	4.8	(9.5)	149.0	(297.9)
105068	(a)	Print, Photo, Pkg, Sat	105.6	(25.3)	18.6	(37.2)	86.8	(173.6)
105069	(a)	Writing, Tech, Cotton	66.8	(16.0)	24.9	(49.8)	42.4	(84.7)
105072	53	Pkg, Ind Conv	171.5	(41.1)	7.4	(14.8)	26.2	(52.3)
120053(b)	150	Asbestos Gaskets	--	(--)	--	(--)	--	(--)
150003	(a)	Asbestos, Electrical Board	--	(--)	--	(--)	--	(--)
150027	(a)	Phenolic Board	--	(--)	--	(--)	--	(--)

(a) Production data held confidential.
(b) Mill is now closed.

Reproduced from best available copy.

TABLE V-28

SUMMARY OF INITIAL SCREENING PROGRAM ANALYSIS RESULTS

Toxic Pollutant	Raw Water (µg/l) Not Detected	Raw Water (µg/l) <10	Raw Water (µg/l) 10-100	Raw Water (µg/l) >100	Raw Water (µg/l) Ave	Raw Wastewater (µg/l) Not Detected	Raw Wastewater (µg/l) <10	Raw Wastewater (µg/l) 10-100	Raw Wastewater (µg/l) >100	Raw Wastewater (µg/l) Ave	Final Effluent (µg/l) Not Detected	Final Effluent (µg/l) <10	Final Effluent (µg/l) 10-100	Final Effluent (µg/l) >100	Final Effluent (µg/l) Ave
1. acenaphthene	11					12					11				
2. acrolein	11					12					11				
3. acrylonitrile	11					12					11				
4. benzene	11					4	6	2		3	6	5			1
5. benzidine	11					12					11				
6. carbon tetrachloride (tetrachloromethane)	11					12					11				
7. chlorobenzene	11					10	1	1		8	11				
8. 1,2,4-trichlorobenzene	11					12					11				
9. hexachlorobenzene	11					12					11				
10. 1,2-dichloroethane	11					11	1			1	10	1			1
11. 1,1,1-trichloroethane	11					7	2	3		6	11				
12. hexachloroethane	11					12					11				
13. 1,1-dichloroethane	11					11	1			1	10	1			1
14. 1,1,2-trichloroethane	11					12					11				
15. 1,1,2,2-tetrachloroethane	11					11	1			1	11				
16. chloroethane	11					12					11				
17. bis(chloromethyl) ether	11					12					11				
18. bis(2-chloroethyl) ether	11					12					11				
19. 2-chloroethyl vinyl ether (mixed)	11					12					11				
20. 2-chloronaphthalene	11					12					11				
21. 2,4,6-trichlorophenol	11					11		1		2	11				
22. parachlorometa cresol	11					12					11				
23. chloroform (trichloromethane)	9	2			1	2	2	2	6	269	3	5	3		16
24. 2-chlorophenol	11					12					11				
25. 1,2-dichlorobenzene	11					12					11				
26. 1,3-dichlorobenzene	11					12					11				
27. 1,4-dichlorobenzene	11					12					11				
28. 3,3'-dichlorobenzidine	11					12					11				
29. 1,1-dichloroethylene	11					12					11				

TABLE V-28 (Continued)

Toxic Pollutant	Raw Water (µg/l) Not Detected	Raw Water (µg/l) <10	Raw Water (µg/l) 10-100	Raw Water (µg/l) >100	Raw Water (µg/l) Ave	Raw Wastewater (µg/l) Not Detected	Raw Wastewater (µg/l) <10	Raw Wastewater (µg/l) 10-100	Raw Wastewater (µg/l) >100	Raw Wastewater (µg/l) Ave	Final Effluent (µg/l) Not Detected	Final Effluent (µg/l) <10	Final Effluent (µg/l) 10-100	Final Effluent (µg/l) >100	Final Effluent (µg/l) Ave
30. 1,2-trans-dichloroethylene	11					12					11				
31. 2,4-dichlorophenol	11					11		1		1	9	2			1
32. 1,2-dichloropropane	11					12					11				
33. 1,3-dichloropropylene (1,3-dichloropropene)	11					12					11				
34. 2,4-dimethylphenol	11					12					11				
35. 2,4-dinitrotoluene	11					12					11				
36. 2,6-dinitrotoluene	11					12					11				
37. 1,2-diphenylhydrazine	11					12					11				
38. ethylbenzene	11					6	5		1	9	9	2			1
39. fluoranthene	11					10	2			1	10	1			1
40. 4-chlorophenyl phenyl ether	11					12					11				
41. 4-bromophenyl phenyl ether	11					12					11				
42. bis(2-chloroisopropyl) ether	11					12					11				
43. bis(2-chloroethoxy) methane	11					12					11				
44. methylene chloride (dichloromethane)	3	2	4	2	54	1	1	6	4	81	1	2	4	4	55
45. methyl chloride (chloromethane)	11					12					11				
46. methyl bromide (bromomethane)	11					12					11				
47. bromoform (tribromomethane)	11					12					11				
48. dichlorobromomethane	11					11	1			1	11				
49. trichlorofluoromethane	11					11			1	23	10			1	19
50. dichlorodifluoromethane	11					12					11				
51. chlorodibromomethane	11					11	1			1	11				
52. hexachlorobutadiene	11					12					11				
53. hexachlorocyclopentadiene	11					12					11				
54. isophorone	11					11		1		5	11				
55. naphthalene	11					11			1	12	11				
56. nitrobenzene	11					12					11				
57. 2-nitrophenol	11					12					11				
58. 4-nitrophenol	11					12					11				
59. 2,4-dinitrophenol	11					12					11				

TABLE V-28 (Continued)

Toxic Pollutant	Raw Water (µg/l) Not Detected	<10	10-100	>100	Ave	Raw Wastewater (µg/l) Not Detected	<10	10-100	>100	Ave	Final Effluent (µg/l) Not Detected	<10	10-100	>100	Ave
60. 4,6-dinitro-o-cresol	11					12					11				
61. N-nitrosodimethylamine	11					12					11				
62. N-nitrosodiphenylamine	11					12					11				
63. N-nitrosodi-n-propylamine	11					12					11				
64. pentachlorophenol	11					12					11				
65. phenol	0	9	2		6	0	2	6	4	624	0	5	5	1	89
66. bis(2-ethylhexyl) phthalate	7	1	3		5	2	1	6	3	66	5		5	1	22
67. butyl benzyl phthalate	11					12					11				
68. di-n-butyl phthalate	4	3	3	1	16	3	1	3	5	85	5	3	2	1	16
69. di-n-octyl phthalate	10	1			1	12					11				
70. diethyl phthalate	10	1			1	7	1	4		7	7	4			1
71. dimethyl phthalate	11					12					11				
72. benzo[a]anthracene (1,2-benzanthracene)	11					12					11				
73. benzo[a]pyrene (3,4-benzopyrene)	11					12					11				
74. 3,4-benzo fluoranthene	11					12					11				
75. benzo[k]fluoranthene (11,12-benzo fluoranthene	11					12					11				
76. chrysene	11					12					11				
77. acenaphthylene	11					11	1			1	11				
78. anthracene	11					12					11				
79. benzo[ghi]perylene (1,12-benzoperylene)	11					8	2	2		9	10	1			1
80. fluorene	11					12					11				
81. phenanthrene	11					12					11				
82. dibenzo[a,h]anthracene (1,2,5,6-dibenzanthracene)	11					12					11				
83. indeno[1,2,3-cd]pyrene (2,3-o-phenylenepyrene)	11					12					11				
84. pyrene	11					12					11				
85. tetrachloroethylene	11					10	2			1	10		1		7
86. toluene	10	1			1	2	8	2		4	4	6	1		4

TABLE V-28 (Continued)

Toxic Pollutant	Raw Water (µg/l) Not Detected	<10	10-100	>100	Ave	Raw Wastewater (µg/l) Not Detected	<10	10-100	>100	Ave	Final Effluent (µg/l) Not Detected	<10	10-100	>100	A
87. trichloroethylene	11					10	2			1	11				
88. vinyl chloride (chloroethylene)	11					12					11				
89. aldrin	11					12					11				
90. dieldrin	11					12					11				
91. chlordane (technical mixture & metabolites)	11					12					11				
92. 4,4'-DDT	11					12					11				
93. 4,4'-DDE (p,p'-DDX)	11					12					11				
94. 4,4'-DDD (p,p'-TDE)	11					12					11				
95. α-endosulfan	11					12					11				
96. β-endosulfan	11					12					11				
97. endosulfan sulfate	11					12					11				
98. endrin	11					12					11				
99. endrin aldehyde	11					12					11				
100. heptachlor	11					12					11				
101. heptachlor epoxide	11					12					11				
102. α-BHC	11					12					11				
103. β-BHC	11					12					11				
104. γ-BHC (lindane)	11					12					11				
105. δ-BHC	11					12					11				
106. PCB-1242 (Arochlor 1242)	11					12					11				
107. PCB-1254 (Arochlor 1254)	11					11	1			1	10	1			1
108. PCB-1221 (Arochlor 1221)	11					12					11				
109. PCB-1232 (Arochlor 1232)	11					12					11				
110. PCB-1248 (Arochlor 1248)	11					12					11				
111. PCB-1260 (Arochlor 1260)	11					12					11				
112. PCB-1016 (Arochlor 1016)	11					12					11				
113. Toxaphene	11					12					11				
114. Antimony (Total)	0	11			1	0	10	2		7	0	10	1		
115. Arsenic (Total)	0	11			3	0	11	1		5	0	10	1		
116. Asbestos (Fibrous)	11					12					11				
117. Beryllium (Total)	0	11			1	0	12			1	0	11			

TABLE V-28 (Continued)

Toxic Pollutant	Raw Water (µg/1) Not Detected	<10	10-100	>100	Ave	Raw Wastewater (µg/1) Not Detected	<10	10-100	>100	Ave	Final Effluent (µg/1) Not Detected	<10	10-100	>100	Ave
118.Cadmium (Total)	0	11			1	12				2	0	11			1
119.Chromium (Total)**	0	6	5		8	0	3	8	1	42	0	7	4		12
120.Copper (Total)**	0	1	10		27	0		8	4	81	0		11		53
121.Cyanide (Total)	0	11			10	0	11		1	26	0	11			10
122.Lead (Total)**	0	6	5		10	0	4	7	1	36	0	5	6		16
123.Mercury (Total)	0	11			1.2	0	12			1.5	0	11			1.5
124.Nickel (Total)**	0	6	5		13	0	2	10		35	0	3	7	1	38
125.Selenium (Total)	0	11			2	0	12			3	0	11			2
126.Silver (Total)	0	10	1		5	0	12			2	0	10	1		6
127.Thallium (Total)	0	11			2	0	12			2	0	11			2
128.Zinc (Total)**	0		9	2	55	0		6	6	555	0		7	4	24
129.2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)	*					*					*				
130.Abietic Acid	11					1		4	7	365	7		3	1	94
131.Dehydroabietic Acid	11					1		1	10	700	5	1	3	2	89
132.Isopimaric Acid	11					11			1	9	11				
133.Pimaric Acid	11					2		5	5	87	8	1	2		12
134.Oleic Acid	11					3	2	4	3	99	6	2	3		16
135.Linoleic Acid	11					6	1	2	3	192	10		1		6
136.Linolenic Acid	11					11			1	18	11				
137.9,10-Epoxystearic Acid	11					11		1		5	11				
138.9,10-Dichlorostearic Acid	11					12					11				
139.Monochlorodehydroabietic Acid	11					8	1	2	1	41	11				
140.Dichlorodehydroabietic Acid	11					11		1		5	11				
141.3,4,5-Trichloroguaiacol	11					11		1		1	10	1			1
142.Tetrachloroguaiacol	11					11		1		1	10	1			1
143.Xylene	11					11			1	44	11				

*Not analyzed.
**Consistent discrepancies existed between split sample results for this compound.

TABLE V-29

SUMMARY OF SCREENING ANALYSIS RESULTS AT 17 VERIFICATION MILLS

Compound Number	Compound Name	Sample Location	ND	Range			Average Concentration (µg/l)
				<10	10-100	>100	
5	Benzidine	Raw Wastewater	15	1	1	0	1.1
		Final Effluent	11	1**	1**	0	1.5
3	Acrylonitrile	Raw Wastewater	16	0	1	0	1.4
		Final Effluent	11	0	2	0	3.2
30	1,2-dichloroethylene	Raw Water	16	1	0	0	0.2
62	N-nitrosodiphenylamine	Raw Wastewater	16	0	1	0	1.0

*Compounds listed are those detected during screening studies conducted at 17 verification mills that were not detected in any wastewater samples taken at the 11 mills sampled during initial screening surveys.

**Final effluent from clarifier at a self contained mill.

TABLE V-30

SUMMARY OF EPA REGIONAL S & A SCREENING PROGRAM RESULTS AT 42 MILLS

Toxic pollutants detected above 10 µg/l	Raw Waste No. of Mills where pollutant was detected	 No. of Mills where pollutant was detected at greater than 10 µg/l	 Concentration Range (µg/l)	Final Effluent No. of Mills where pollutant was detected	 No. of Mills where pollutant was detected at greater than 10 µg/l	 Concentrations Range (µg/l)
4. benzene	10	3	ND- 30	10	2	ND- 80
11. 1,1,1-trichloroethane	9	4	ND- 70	7	1	ND- 16
15. 1,1,2,2-tetrachloroethane	0	0	ND	1	1	ND- 24
17. bis(chloromethyl) ether	0	0	ND	1	1	ND- 12
18. bis(2-chloroethyl) ether	1	1	4,900- 7,200	--	--	-
21. 2,4,6-trichlorophenol	21	10	ND- 263	16	3	ND- 14
23. chloroform	35	26	ND- 5,500	24	16	ND- 1,200
29. 1,1-dichloroethylene	4	0	ND- <10	4	1	ND- 86
31. 2,4-dichlorophenol	16	5	ND- 223	9	1	ND- 41
34. 2,4-dimethylphenol	9	5	ND- 85	4	0	ND- <10
35. 2,4-dinitrotoluene	0	0	ND	1	1	ND- 14
36. 2,6-dinitrotoluene	0	0	ND	1	1	ND- 15
43. bis(2-chloroethoxy) methane	1	1	ND- 74	0	0	ND
44. methylene chloride	16	13	ND-10,000	15	10	ND- 3,600
47. bromoform	1	0	<10	1	1	ND- 13
48. dichlorobromomethane	8	2	ND- 88	1	0	ND- <10
49. trichlorofluoromethane	5	1	ND- 48	1	1	35- 260
51. chlorodibromomethane	2	1	ND- 14	2	0	ND- <10
53. hexachlorocyclopentadiene	1	1	<10- 16	--	--	-
55. naphthalene	10	2	ND- 74	4	0	ND- <10
56. nitrobenzene	3	1	ND- 50	1	0	ND- <10
58. 4-nitrophenol	1	1	<10- 18	1	0	ND- <10
62. N-nitrosodiphenylamine	2	0	ND- <10	1	1	17- 32
64. pentachlorophenol	10	4	ND- 54	6	2	ND- 32
65. phenol	34	25	ND- 940	13	4	ND- 53
66. bis(2-ethylhexyl) phthalate	27	11	ND- 624	28	12	ND- 1,740
67. butyl benzyl phthalate	9	2	ND- 240	7	2	ND- 30
68. di-n-butyl pithalate	17	4	ND- 380	19	2	ND- 15
70. diethyl phthalate	12	5	ND- 67	7	0	ND- 10
71. dimethyl phthalate	5	1	ND- 31	1	0	ND- <10
82. dibenzo[a,h]anthracene	1	1	38	0	0	ND
85. tetrachloroethylene	10	2	ND- 40	6	0	ND- <10
86. toluene	23	7	ND- 200	15	3	ND- 200
87. trichloroethylene	8	0	ND- <10	5	1	<10- 15
112. PCB-1016 (Aroclor 1016)	1	1	<10- 12	0	0	ND

Reproduced from best available copy.

TABLE V-30 (Continued)

Metals, Cyanide, and Total Phenolics	Raw Waste: No. of Mills where pollutant was detected	Raw Waste: No. of Samples detected at 10 to 99 µg/l	Raw Waste: No. of Samples detected at 100 to 999 µg/l	Raw Waste: No. of Samples at greater than 1 mg/l	Final Effluent: No. of Mills where pollutant was detected	Final Effluent: No. of Samples detected at 10 to 99 µg/l	Final Effluent: No. of Samples detected at 100 to 999 µg/l	Final Effluent: No. of Samples at greater than 1 mg/l
114. Antimony	12	14	4	0	6	11	0	0
115. Arsenic	8	9	0	0	2	2	0	0
117. Beryllium	43	49	0	0	40	40	0	0
118. Cadmium	9	12	0	0	5	5	0	0
119. Chromium	40	58	24	0	24	33	17	0
120. Copper	41	75	18	2	28	64	3	1
121. Cyanide	15	25	6	1	6	11	0	0
122. Lead	29	28	24	0	18	19	13	0
124. Nickel	27	36	20	0	23	28	13	0
125. Selenium	3	5	0	0	7	10	0	0
126. Silver	3	6	0	0	1	3	0	0
127. Thallium	4	10	0	0	6	12	0	0
128. Zinc	50	45	52	12	39	58	25	4
Total Phenolics	40	16	46	29	32	45	21	2

The following pollutants were detected in at least one raw waste and one final effluent sample at a concentration of less than 10 µg/l:

6. carbon tetrachloride
7. chlorobenzene
24. 2-chlorophenol
25. 1,2-dichlorobenzene
38. ethylbenzene
39. fluoranthene
54. isophorone
59. 2,4-dinitrophenol
69. di-n-octyl phthalate
81. phenanthrene/anthracene
84. pyrene

The following pollutants were detected in at least one final effluent sample at a concentration of less than 10 µg/l:

14. 1,1,2-trichloroethane
20. 2-chloronaphthalene
33. 1,3-dichloropropylene

The following pollutants were detected in at least one raw waste sample at a concentration of less than 10 µg/l:

10. 1,2-dichloroethane
13. 1,1-dichloroethane
22. parachlorometa cresol
27. 1,4-dichlorobenzene
42. bis(2-chloroisopropyl) ether
45. methyl chloride
60. 4,6-dinitro-o-cresol
77. acenaphthylene

Verification Program

As described previously, the contractor's initial screening survey results, industry survey responses, and available literature were reviewed to develop a list of parameters to be studied in verification sampling. Table II-8 presents a list of the priority and nonconventional pollutants analyzed as part of the verification program. During verification sampling at 17 mills where processes were employed that were characteristic of the four mill groupings not a part of the initial contractor screening program, screening studies were also conducted. As a result of this supplemental screening program, three additional priority pollutants not included on the verification compound list were identified. However, as shown earlier on Table V-29, the level and frequency of discharge of these compounds did not warrant a review of the existing GC/MS data tapes for the remaining 43 verification program mills to further investigate the presence of these three compounds in pulp, paper, and paperboard industry discharges.

Verification samples were analyzed by GC/MS procedures that included a quality control/quality assurance program developed specifically for the analysis of pulp, paper, and paperboard wastewater samples. As discussed in Section II, these procedures were developed to provide higher quality analytical results than could be obtained using the screening procedures.

In the verification program, data were obtained on 42 organic priority pollutants, 6 metals, cyanide, 14 nonconventional organics (xylene, 4 resin acids, 3 fatty acids, and 6 bleach plant derivatives), color, ammonia, and COD.

Table V-31 presents a summary of the verification program priority pollutant analysis results by compound and subcategory. The table shows the number of samples taken at mills in each subcategory and the number of samples in which the specific compound was detected. The ranges of concentrations and the average concentration of specific compounds at those mills where the compound was detected are also shown. Results for both raw waste and final effluent sampling points are presented.

Table V-32 presents a summary of the results of analysis for the additional nonconventional pollutants investigated during verification sampling. The same methodology and format utilized in Table V-31 has been used to present summary information in Table V-32.

Long-Term Sampling Program

As discussed in Section II, the Agency conducted a long-term sampling program to obtain additional toxic and nonconventional pollutant data. Tables V-33 and V-34 present summaries of toxic and nonconventional pollutant data obtained during sampling of a deink mill and a fine bleached kraft mill. Both tables present information on the number of

TABLE V-31

SUMMARY OF VERIFICATION PROGRAM ANALYSIS RESULTS FOR TOXIC POLLUTANTS

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (μg/l) Influent	*Concentration Range (μg/l) Effluent	**Average Concentration (μg/l) Influent	**Average Concentration (μg/l) Effluent	Comments Influent/Effluent
4. Benzene									
Market Bleached Kraft	6	6	1	3	0- 3	2- 3	1	2	Biological Treatment
BCT Bleached Kraft	9	9	0	1	0	0- 2	0	1	Biological Treatment
Unbleached Kraft									
o Bag	6	6	1	2	0- 1	0- 3	1	1	Biological Treatment
Semi-Chemical	6	6	3	2	5- 6	0- 3	5	2	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	3	0	1- 5	0	3	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	2	0	0- 2	0	1	0	Biological Treatment
Papergrade Sulfite	12	12	7	5	0- 150	0- 96	57	16	Biological Treatment
Deink									
o Fine Papers	3	3	1	1	0- 7	0- 3	2	1	Biological Treatment
o Tissue Papers	3	3	2	3	0- 6	2- 3	3	3	Partial Final Effluent
	3	3	0	1	0	0- 4	0	1	Biological Treatment
Tissue From Wastepaper	6	6	0	1	0	0- 1	0	1	Biological Treatment
	3	3	1	0	0- 1	0	1	0	Primary Treatment
Paperboard From Wastepaper	15	15	1	0	0- 1	0	1	0	Biological Treatment
	3	3	0	1	0	0- 3	0	1	Primary Treatment
Builders' Paper and Roofing Felt	9	--	2	--	0- 4	--	1	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Fine Papers	6	6	0	0	0	0	0	0	Biological Treatment
	3	3	1	2	0- 1	0- 2	1	1	Primary Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	0	0	0	0	0	0	Biological Treatment
	3	3	0	1	0	0- 4	0	1	Primary Treatment

* Range for those mills where pollutant was detected in influent or effluent.

** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (µg/l) Influent	*Concentration Range (µg/l) Effluent	**Average Concentration (µg/l) Influent	**Average Concentration (µg/l) Effluent	Comments Influent/Effluent
4. Benzene (continued)									
Nonintegrated-Paperboard	6	6	2	1	0- 4	0- 2	1	1	Biological Treatment
Integrated Miscellaneous	12	12	3	1	6- 11	0- 2	9	1	Biological Treatment
Nonintegrated Miscellaneous	6	6	2	1	0- 1	0- 2	1	1	Primary Treatment
	3	3	0	0	0	0	0	0	Primary w/Holding Ponds
6. Carbon Tetrachloride	Not detected								
7. Chlorobenzene Deink o Tissue Papers	3	3	3	0	37- 47	0	43	0	Partial Final Effluent
	3	3	0	0	0	0	0	0	Biological Treatment
10. 1,2-Dichloroethane Deink o Tissue Papers	3	3	2	0	0- 5	0	3	0	Partial Final Effluent
	3	3	0	0	0	0	0	0	Biological Treatment
Nonintegrated-Fine Papers	6	6	1	3	0- 2	1- 2	1	2	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
11. 1,1,1-Trichloroethane Alkaline-Fine	9	9	1	0	0- 71	0	24	0	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	3	0	3- 7	0	5	0	Biological Treatment
Papergrade Sulfite	12	12	3	3	130-2,000	6- 8	1,243	7	Biological Treatment
Deink o Fine Papers	3	3	3	0	6- 53	0	22	0	Biological Treatment
Paperboard From Wastepaper	15	15	7	0	0- 4	0	2	0	Biological Treatment
	3	3	2	3	0- 5	2- 4	2	3	Primary Treatment
Builders' Paper and Roofing Felt	9	--	7	--	0- 20	--	7	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
Integrated Miscellaneous	12	12	3	0	3- 187	0	67	0	Biological Treatment
Nonintegrated Miscellaneous	6	6	3	3	4- 9	1- 5	6	2	Primary Treatment
	3	3	3	3	7- 22	4- 17	14	10	Primary w/Holding Pond

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

	Total Number Of Samples		Total Number Of Detected Analyses		*Concentration Range (µg/l)		**Average Concentration (µg/l)		Comments
Toxic Pollutant/Subcategory	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent/Effluent
13. 1,1-Dichloroethane									
Papergrade Sulfite	12	12	3	0	5- 22	0	12	0	Biological Treatment
15. 1,1,2,2-Tetrachloroethane	Not detected								
21. 2,4,6-Trichlorophenol									
Market Bleached Kraft	6	6	6	6	1- 26	3- 6	11	5	Biological Treatment
BCT Bleached Kraft	9	9	8	1	0- 21	0- 2	8	1	Biological Treatment
Alkaline-Fine	9	9	9	7	3- 23	0- 8	11	3	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	7- 15	1- 7	11	5	Biological Treatment
Papergrade Sulfite	12	12	6	6	10- 370	2- 270	181	106	Biological Treatment
Deink									
o Fine Papers	3	3	2	1	0- 16	0- 21	7	7	Biological Treatment
o Tissue Papers	3	3	3	3	29- 65	39- 43	48	41	Partial Final Effluent
	3	3	0	0	0	0	0	0	Biological Treatment
Paperboard From Wastepaper	15	15	5	2	0- 5	0- 6	2	1	Biological Treatment
	3	3	3	3	270- 420	420- 450	360	430	Primary Treatment
Integrated Miscellaneous	12	12	1	1	0- 18	0- 3	6	1	Biological Treatment
Nonintegrated Miscellaneous	6	6	3	3	6- 30	6- 28	18	19	Primary Treatment
	3	3	0	0	0	0	0	0	Primary w/Holding Pond
22. Parachlorometa Cresol	Not detected								
23. Chloroform									
Dissolving Kraft	3	3	3	3	360- 900	40- 86	647	67	Biological Treatment
Market Bleached Kraft	6	6	6	6	830-2,200	6- 20	1,405	12	Biological Treatment
BCT Bleached Kraft	9	9	9	8	580-4,000	0- 11	1,550	6	Biological Treatment
Alkaline-Fine	9	9	9	9	43-1,800	2- 110	1,148	52	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	0	1- 2	0	1	0	Biological Treatment
Semi-Chemical	6	6	3	0	1- 4	0	2	0	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	2	0	0- 6	0	3	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	110- 360	1- 42	268	13	Biological Treatment
Papergrade Sulfite	12	12	12	12	62-8,600	120-1,200	2,677	433	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	17- 240	4- 36	99	15	Biological Treatment

* Range for those mills where pollutant was detected in influent or effluent.

** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (µg/l) Influent	*Concentration Range (µg/l) Effluent	**Average Concentration (µg/l) Influent	**Average Concentration (µg/l) Effluent	Comments Influent/Effluent
23. Chloroform (continued)									
Deink									
o Fine Papers	3	3	3	3	670-9,700	95-240	4,190	145	Biological Treatment
o Tissue Papers	3	3	3	3	1,000-1,800	48-61	1,367	55	Partial Final Effluent
	3	3	3	3	12-46	2-10	25	5	Biological Treatment
o Newsprint	3	--	3	--	1	--	1	--	POTW
Tissue From Wastepaper	6	6	1	0	0-9	0-	3	0	Biological Treatment
	3	3	0	1	0	0-1	0	1	Primary Treatment
Paperboard From Wastepaper	15	15	11	3	0-40	0-20	15	4	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Builders' Paper and Roofing Felt	9	--	3	--	2-21	--	10	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated Fine Papers	6	6	3	3	0-26	0-6	6	3	Biological Treatment
	3	3	3	3	4-9	4-6	7	5	Primary Treatment
Nonintegrated Tissue Papers	3	3	3	3	2-4	4	3	4	Primary Treatment
	3	3	0	0	0	0	0	0	Biological Treatment
Nonintegrated Lightweight Papers	3	3	3	3	15-51	2-3	27	3	Biological Treatment
Integrated Miscellaneous	12	12	4	3	0-1,100	0-14	417	5	Biological Treatment
Nonintegrated Miscellaneous	6	6	3	3	3-15	2-6	8	4	Primary Treatment
	3	3	0	0	0	0	0	0	Primary w/Holding Pond
24. 2-Chlorophenol									
Papergrade Sulfite	12	12	2	3	0-120	21-50	65	37	Biological Treatment
Deink									
o Fine Papers	3	3	1	0	0-2	0	1	0	Biological Treatment
31. 2,4-Dichlorophenol									
Market Bleached Kraft	6	6	4	4	0-8	0-8	4	4	Biological Treatment
BCT Bleached Kraft	9	9	4	2	0-4	0-1	2	1	Biological Treatment
Alkaline-Fine	9	9	2	1	0-6	0-5	3	2	Biological Treatment
Dissolving Sulfite Pulp	4	4	2	7	0-4	0-1	2	1	Biological Treatment
Papergrade Sulfite	12	12	6	3	2-220	0-130	103	53	Biological Treatment

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (µg/l) Influent	*Concentration Range (µg/l) Effluent	**Average Concentration (µg/l) Influent	**Average Concentration (µg/l) Effluent	Comments Influent/Effluent
31. 2,4-Dichlorophenol (continued)									
Deink									
o Fine Papers	3	3	1	1	0-5	0-3	2	1	Biological Treatment
o Tissue Papers	3	3	3	2	1-5	0-2	4	1	Partial Final Effluent
	3	3	0	0	0	0	0	0	Biological Treatment
38. Ethylbenzene									
Market Bleached Kraft	6	6	1	0	0-82	0	27	0	Biological Treatment
BCT Bleached Kraft	9	9	0	1	0	0-3	0	1	Biological Treatment
Unbleached Kraft									
o Bag	6	6	3	0	1-2	0	2	0	Biological Treatment
Semi-Chemical	6	6	2	2	0-2	0-2	1	1	Biological Treatment
Groundwood-Fine Papers	6	6	1	0	0-3	0	1	0	Biological Treatment
Deink									
o Newsprint	3	--	2	--	0-4	--	2	--	POTW
o Tissue Papers	3	3	3	0	27-45	0	33	0	Partial Final Effluent
	3	3	0	0	0	0	0	0	Biological Treatment
Tissue From Wastepaper	6	6	3	0	2-74	0	27	0	Biological Treatment
	3	3	1	0	0-5	0	2	0	Primary Treatment
Builders' Paper and Roofing Felt	9	--	3	--	1-11	--	5	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Tissue Papers	3	3	3	3	54-39,000	36-300	13,081	149	Primary Treatment
	3	3	0	0	0	0	0	0	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	1	0	0-2	0	1	0	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Paperboard	6	6	3	2	2-6	0-2	3	1	Biological Treatment
Integrated Miscellaneous	12	12	1	0	0-2	0	1	0	Biological Treatment
Nonintegrated Miscellaneous	6	6	2	0	0-32	0	13	0	Primary Treatment
	3	3	0	0	0	0	0	0	Primary w/Holding Pond
39. Fluoranthene									
Dissolving Kraft	3	3	1	0	0-7	0	2	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	1	1	0-4	0-1	1	1	Biological Treatment

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (µg/l) Influent	*Concentration Range (µg/l) Effluent	**Average Concentration (µg/l) Influent	**Average Concentration (µg/l) Effluent	Comments Influent/Effluent
44. Methylene Chloride									
Dissolving Kraft	3	3	1	0	0- 1	0	1	0	Biological Treatment
Market Bleached Kraft	6	6	3	2	1- 2	0- 2	1	1	Biological Treatment
BCT Bleached Kraft	9	9	7	6	0- 4	0- 4	2	2	Biological Treatment
Alkaline-Fine	9	9	3	2	2- 3	0- 1	3	1	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	0	2- 3	0	2	0	Biological Treatment
o Bag	6	6	4	5	0- 290	0- 6	50	4	Biological Treatment
Semi-Chemical	6	6	4	6	0- 21	1- 14	6	5	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	3	1	0- 220	0- 80	58	13	Biological Treatment
Dissolving Sulfite Pulp	4	4	3	1	0- 3	0- 2	2	1	Biological Treatment
Papergrade Sulfite	12	12	10	12	0-2,500	2-3,100	291	271	Biological Treatment
Groundwood-Fine Papers	6	6	1	0	0- 13	0	4	0	Biological Treatment
Deink									
o Tissue Papers	3	3	3	3	11- 14	1- 3	12	2	Partial Final Effluent
	3	3	0	0	0	0	0	0	Biological Treatment
o Newsprint	3	--	1	--	0- 3	--	1	0	POTW
Tissue From Wastepaper	6	6	3	0	17- 410	0	174	0	Biological Treatment
	3	3	3	2	1- 11	0- 4	5	2	Primary Treatment
Paperboard From Wastepaper	15	15	6	3	0- 4	0- 4	2	1	Biological Treatment
	3	3	0	3	0	3- 142	0	50	Primary Treatment
Wastepaper-Molded Products	3	3	2	1	0- 2	0- 1	1	1	Biological Treatment
	3	--	0	--	0	--	0	--	POTW
Builders' Paper and Roofing Felt	9	--	4	--	0- 6	--	2	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Fine Papers	6	6	1	2	0- 1	0- 1	1	1	Biological Treatment
	3	3	2	3	0- 17	5- 8	7	7	Primary Treatment
Nonintegrated-Lightweight Papers	3	3	1	2	0- 2	0- 2	1	1	Biological Treatment
Nonintegrated-Paperboard	6	6	1	0	0- 3	0	1	0	Biological Treatment
Integrated Miscellaneous	12	12	4	4	0- 10	0- 12	2	2	Biological Treatment

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (µg/l) Influent	*Concentration Range (µg/l) Effluent	**Average Concentration (µg/l) Influent	**Average Concentration (µg/l) Effluent	Comments Influent/Effluent
47. Bromoform									
Paperboard From Wastepaper	15	15	0	0	0	0	0	0	Biological Treatment
	3	3	1	1	0- 119	0- 62	40	21	Primary Treatment
48. Dichlorobromomethane									
Dissolving Kraft	3	3	1	0	0- 4	0	1	0	Biological Treatment
Alkaline-Fine	9	9	3	0	13- 18	0	15	0	Biological Treatment
Papergrade Sulfite	12	12	3	1	8- 40	0- 5	26	2	Biological Treatment
Paperboard From Wastepaper	15	15	0	0	0	0	0	0	Biological Treatment
	3	3	1	3	0- 3	1- 2	1	1	Primary Treatment
Builders' Paper and Roofing Felt	9	--	1	--	0- 14	--	5	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
49. Trichlorofluoromethane									
Builders' Paper and Roofing Felt	9	--	1	--	0- 8	--	3	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
51. Dibromochloromethane									
Builders' Paper and Roofing Felt	9	--	1	--	0- 5	--	2	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
54. Isophorone									
Unbleached Kraft o Linerboard	3	3	3	0	8- 15	0	11	0	Biological Treatment
55. Naphthalene									
Semi-Chemical	6	6	2	0	0- 5	0	3	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	3	0	3- 4	0	4	0	Biological Treatment
Papergrade Sulfite	12	12	3	3	22- 230	7- 88	102	36	Biological Treatment

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (µg/l) Influent	*Concentration Range (µg/l) Effluent	**Average Concentration (µg/l) Influent	**Average Concentration (µg/l) Effluent	Comments Influent/Effluent
55. Naphthalene (continued)									
Deink									
o Fine Papers	3	3	3	0	67- 190	0	142	0	Biological Treatment
o Tissue Papers	3	3	2	0	0- 78	0	48	0	Partial Final Effluent
	3	3	0	0	0	0	0	0	Biological Treatment
Tissue From Wastepaper	6	6	0	0	0	0	0	0	Biological Treatment
	3	3	3	2	16- 43	0- 27	26	18	Primary Treatment
Integrated Miscellaneous	12	12	1	0	0- 4	0	1	0	Biological Treatment
59. 2,4-dinitrophenol		Not detected							
64. Pentachlorophenol									
BCT Bleached Kraft	9	9	3	3	5- 31	16- 21	19	19	Biological Treatment
Alkaline-Fine	9	9	3	2	6- 11	0- 1	8	1	Biological Treatment
Semi-Chemical	6	6	1	1	0- 5	0- 2	2	1	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	1	0	0- 7	0	2	0	Biological Treatment
Papergrade Sulfite	12	12	6	1	1- 12	0- 1	6	1	Biological Treatment
Groundwood-Fine Papers	6	6	3	2	3- 12	0- 2	6	1	Biological Treatment
Deink									
o Fine Papers	3	3	3	3	9- 24	4- 20	15	12	Biological Treatment
o Tissue Papers	3	3	3	3	10- 61	27- 38	38	34	Partial Final Effluent
	3	3	0	0	0	0	0		Biological Treatment
Paperboard From Wastepaper	15	15	5	0	0- 19	0	6	0	Biological Treatment
	3	3	3	3	850-1,200	1,100-1,400	1,050	1,200	Primary Treatment
Wastepaper-Molded Products	3	3	1	1	0- 6	0- 4	2	1	Biological Treatment
	3	--	0	--	0	--	0	--	POTW
Builders' Paper and Roofing Felt	9	--	6	--	17- 160	--	65	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
Integrated Miscellaneous	12	12	4	2	0- 29	0- 5	12	1	Biological Treatment
Nonintegrated Miscellaneous	6	6	0	0	0	0	0	0	Primary Treatment
	3	3	2	2	0- 200	0- 68	72	27	Primary w/Holding Pond
65. Phenol									
Dissolving Kraft	3	3	3	3	8- 110	10- 29	54	18	Biological Treatment
Market Bleached Kraft	6	6	6	5	13- 26	0- 2	20	1	Biological Treatment

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (μg/l) Influent	*Concentration Range (μg/l) Effluent	**Average Concentration (μg/l) Influent	**Average Concentration (μg/l) Effluent	Comments Influent/Effluent
65. Phenol (continued)									
BCT Bleached Kraft	9	9	9	4	25- 92	0- 17	55	5	Biological Treatment
Alkaline-Fine	9	9	6	2	4- 14	0- 2	11	1	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	3	41- 110	3- 4	77	3	Biological Treatment
o Bag	6	6	6	0	50- 140	0	89	0	Biological Treatment
Semi-Chemical	6	6	6	6	160- 400	3- 24	230	14	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	0	30- 100	0	56	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	12- 19	1- 10	14	5	Biological Treatment
Papergrade Sulfite	12	12	11	8	0- 640	0- 250	176	41	Biological Treatment
Groundwood-Fine Papers	6	6	6	4	15- 51	0- 5	28	2	Biological Treatment
Deink									
o Fine Papers	3	3	3	0	8- 41	0	22	0	Biological Treatment
o Tissue Papers	3	3	3	0	76- 150	0	119	0	Partial Final Effluent
	3	3	0	0	0	0	0	0	Biological Treatment
o Newsprint	3	--	1	--	0- 4	--	1	--	POTW
Tissue From Wastepaper	6	6	6	4	4- 140	0- 6	41	2	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Paperboard From Wastepaper	3	3	3	3	430- 500	310- 520	457	427	Primary Treatment
	15	15	15	2	6- 91	0- 13	41	1	Biological Treatment
Wastepaper-Molded Products	3	--	3	--	4- 8	--	6	--	POTW
	3	3	3	1	7- 9	0- 3	8	1	Biological Treatment
Builders' Paper and Roofing Felt	3	3	3	3	1,100-1,400	1,200-1,700	1,233	1,433	Primary Treatment
	9	--	9	--	51- 280	--	134	--	POTW
Nonintegrated-Fine Papers	3	3	3	3	44- 150	22- 66	94	38	Primary Treatment
	6	6	4	0	0- 25	0	6	0	Biological Treatment
Nonintegrated-Tissue Papers	3	3	3	2	1- 11	0- 9	5	4	Biological Treatment
	3	3	2	2	0- 2	0- 3	1	2	Primary Treatment
Nonintegrated-Lightweight Papers	3	3	2	2	0- 4	0- 3	2	2	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	0	2	0	0- 17	0	10	Primary Treatment
	3	3	3	1	8- 150	0- 3	64	1	Biological Treatment
Nonintegrated-Paperboard	6	6	6	3	2- 10	0- 3	6	2	Biological Treatment

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (µg/l) Influent	*Concentration Range (µg/l) Effluent	**Average Concentration (µg/l) Influent	**Average Concentration (µg/l) Effluent	Comments Influent/Effluent
65. Phenol (continued)									
Integrated Miscellaneous	12	12	9	7	0- 68	0- 15	15	4	Biological Treatment
Nonintegrated Miscellaneous	3	3	2	2	0- 5	0- 3	3	1	Primary w/Holding Pond
	6	6	4	4	0- 14	0- 8	6	3	Primary Treatment
66. Bis(2-ethylhexyl) Phthalate									
Dissolving Kraft	3	3	3	1	15- 180	0- 4	72	1	Biological Treatment
Market Bleached Kraft	6	6	6	4	6- 21	7- 94	14	32	Biological Treatment
BCT Bleached Kraft	9	9	8	6	0- 35	0- 11	8	3	Biological Treatment
Alkaline-Fine	9	9	7	6	0- 190	0- 49	29	16	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	1	3- 130	0- 9	49	3	Biological Treatment
o Bag	6	6	2	1	0- 7	0- 4	4	1	Biological Treatment
Semi-Chemical	6	6	5	6	0- 46	3- 29	21	15	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	5	5	0- 16	0- 14	10	10	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	2- 22	3- 38	9	14	Biological Treatment
Papergrade Sulfite	12	12	9	5	0- 200	0- 91	29	21	Biological Treatment
Groundwood-Fine Papers	6	6	4	6	0- 18	2- 14	7	7	Biological Treatment
Deink									
o Fine Papers	3	3	2	1	0- 10	0- 4	4	3	Biological Treatment
o Tissue Papers	3	3	3	0	4- 26	3- 5	13	4	Partial Final Effluent
	3	3	2	1	0- 20	0- 2	8	1	Biological Treatment
o Newsprint	3	--	3	--	8- 20	--	13	--	POTW
Tissue From Wastepaper	3	3	3	1	3- 5	0- 1	4	1	Primary Treatment
	6	6	5	3	0- 19	0- 8	10	3	Biological Treatment
Paperboard From Wastepaper	3	3	3	1	17- 34	0- 20	23	7	Primary Treatment
	15	15	13	10	0- 83	0-1,200	14	87	Biological Treatment
Wastepaper-Molded Products	3	--	3	--	11- 18	--	14	--	POTW
	3	3	3	1	1- 4	0- 2	3	1	Biological Treatment
Builders' Paper and Roofing Felt	9	--	9	--	5- 80	--	35	--	POTW
Nonintegrated-Fine Papers	3	3	0	0	0	0	0	0	Primary Treatment
	3	3	3	3	410-2,500	28-2,494	1,193	869	Primary Treatment
	6	6	3	4	0- 13	0- 25	3	6	Biological Treatment

---

* Range for those mills where pollutant was detected in influent or effluent.

** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples		Total Number Of Detected Analyses		*Concentration Range (µg/l)		**Average Concentration (µg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent/Effluent
66. Bis(2-ethylhexyl) Phthalate (continued)									
Nonintegrated-Tissue Papers	3	3	3	3	8- 73	8- 38	30	23	Biological Treatment
	3	3	3	2	6- 13	0- 13	8	7	Primary Treatment
Nonintegrated-Lightweight Papers	3	3	3	3	4- 7	6- 7	5	7	Biological Treatment
Nonintegrated-Filter and Non-Woven Papers	3	3	1	2	0- 1	0- 4	1	2	Primary Treatment
	3	3	3	3	14- 160	13- 61	85	31	Biological Treatment
Nonintegrated-Paperboard	6	6	6	3	4- 31	0- 7	11	2	Biological Treatment
Integrated Miscellaneous	12	12	9	9	0- 25	0- 220	8	25	Biological Treatment
Nonintegrated Miscellaneous	3	3	3	3	6- 15	1- 26	11	15	Primary w/Holding Pond
	6	6	6	6	3- 150	1- 11	34	6	Primary Treatment
67. Butyl Benzyl Phthalate									
Unbleached Kraft									
o Bag	6	6	2	0	0- 39	0	23	0	Biological Treatment
Semi-Chemical	6	6	1	0	0- 1	0	1	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	0	1	0	0- 2	0	1	Biological Treatment
Deink									
o Newsprint	3	--	3	--	3- 8	--	5	--	POTW
Paperboard From Wastepaper	3	3	3	3	17- 190	38- 81	80	63	Primary Treatment
	15	15	4	0	0- 170	0	51	0	Biological Treatment
Builders' Paper and Roofing Felt	3	3	0	0	0	0	0	0	Primary Treatment
	9	--	3	--	5- 12	--	9	--	POTW
Nonintegrated-Tissue Papers	3	3	3	1	620- 950	0- 15	797	5	Primary Treatment
	3	3	0	0	0	0	0	0	Biological Treatment
68. Di-n-Butyl Phthalate									
Dissolving Kraft	3	3	2	1	0- 13	0- 3	7	1	Biological Treatment
Market Bleached Kraft	6	6	6	5	3- 4	0- 19	4	8	Biological Treatment
BCT Bleached Kraft	9	9	5	1	0- 27	0- 23	9	4	Biological Treatment
Alkaline-Fine	9	9	2	1	0- 2	0- 2	1	1	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	3	1- 10	1- 2	7	1	Biological Treatment
o Bag	6	6	1	0	0- 1	0	1	0	Biological Treatment
Semi-Chemical	6	6	6	0	1- 11	0	4	0	Biological Treatment

---

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (μg/l) Influent	*Concentration Range (μg/l) Effluent	**Average Concentration (μg/l) Influent	**Average Concentration (μg/l) Effluent	Comments Influent/Effluent
68. Di-n-Butyl Phthalate (continued)									
Unbleached Kraft and Semi-Chemical	6	6	4	0	0- 12	0	5	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	2	1	0- 2	0- 1	1	1	Biological Treatment
Papergrade Sulfite	12	12	1	0	0- 3	0	1	0	Biological Treatment
Groundwood-Fine Papers	6	6	4	4	0- 8	0- 11	3	4	Biological Treatment
Deink									
o Fine Papers	3	3	3	2	3- 9	0- 12	5	6	Biological Treatment
o Tissue Papers	3	3	1	2	0- 10	0- 12	3	5	Partial Final Effluent
	3	3	0	0	0	0	0	0	Biological Treatment
o Newsprint	3	--	1	--	0- 2	--	1	--	POTW
Tissue From Wastepaper	3	3	0	0	0	0	0	0	Primary Treatment
	6	6	1	0	0- 17	0	6	0	Biological Treatment
Paperboard From Wastepaper	3	3	2	3	0- 85	30- 55	32	44	Primary Treatment
	15	15	11	0	0- 21	0	9	0	Biological Treatment
Builders' Paper and Roofing Felt	3	3	0	0	0	0	0	0	Primary Treatment
	9	--	5	--	0- 25	--	9	--	POTW
Nonintegrated-Tissue Papers	3	3	1	0	0- 3	0	1	0	Primary Treatment
	3	3	0	0	0	0	0	0	Biological Treatment
Nonintegrated-Lightweight Papers	3	3	1	1	0- 3	0- 5	1	2	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	0	1	0	0- 2	0	1	Primary Treatment
	3	3	0	0	0	0	0	0	Biological Treatment
Nonintegrated-Paperboard	6	6	3	1	110- 230	0- 61	180	20	Biological Treatment
Integrated Miscellaneous	12	12	4	2	0- 7	0- 4	1	1	Biological Treatment
69. Di-n-Octyl Phthalate	Not detected								
70. Diethyl Phthalate									
Dissolving Kraft	3	3	1	0	0- 7	0	2	0	Biological Treatment
Market Bleached Kraft	6	6	3	0	0- 2	0	1	0	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	2	0	0- 20	0	13	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	1	0	0- 9	0	9	0	Biological Treatment
Papergrade Sulfite	12	12	1	1	0- 5	0- 14	2	5	Biological Treatment

---

* Range for those mills where pollutant was detected in influent or effluent.

** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (µg/l) Influent	*Concentration Range (µg/l) Effluent	**Average Concentration (µg/l) Influent	**Average Concentration (µg/l) Effluent	Comments Influent/Effluent
70. Diethyl Phthalate (continued)									
Deink									
o Fine Papers	3	3	1	2	0- 10	0- 6	3	2	Biological Treatment
o Newsprint	3	--	1	--	0- 4	--	1	--	POTW
Tissue From Wastepaper	3	3	0	0	0	0	0	0	Primary Treatment
	6	6	2	0	0- 55	0	26	0	Biological Treatment
Paperboard From Wastepaper	3	3	3	3	12- 210	220- 320	79	273	Primary Treatment
	15	15	6	3	38- 690	0- 310	234	71	Biological Treatment
Builders' Paper and Roofing Felt	3	3	0	0	0	0	0	0	Primary Treatment
	9	--	6	--	0- 180	--	29	--	POTW
Nonintegrated-Tissue Papers	3	3	1	0	0- 35	0	12	0	Primary Treatment
	3	3	0	0	0	0	0	0	Biological Treatment
Nonintegrated-Paperboard	6	6	1	2	0- 12	0- 130	4	58	Biological Treatment
Integrated Miscellaneous	12	12	5	2	0- 6	0- 4	2	1	Biological Treatment
76. Chrysene	Not detected								
77. Acenaphthylene	Not detected								
78. Anthracene									
Dissolving Kraft	3	3	1	0	0- 5	0	2	0	Biological Treatment
BCT Bleached Kraft	9	9	1	0	0- 3	0	1	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	0	1	0	0- 1	0	1	Biological Treatment
81. Phenanthrene	Not detected								
84. Pyrene									
Dissolving Kraft	3	3	1	0	0- 6	0	2	0	Biological Treatment
85. Tetrachloroethylene									
BCT Bleached Kraft	9	9	3	0	1- 5	0	3	0	Biological Treatment
Alkaline-Fine	9	9	1	0	0- 3	0	1	0	Biological Treatment
Unbleached Kraft									
o Bag	6	6	2	0	0- 2	0	1	0	Biological Treatment
Papergrade Sulfite	12	12	0	2	0-	0- 6	0	3	Biological Treatment
Groundwood-Fine Papers	6	6	1	0	0- 2	0	1	0	Biological Treatment
Deink									
o Fine	3	3	3	0	22- 180	0	95	0	Biological Treatment
Tissue From Wastepaper	3	3	2	1	0- 220	0- 57	74	19	Primary Treatment
	6	6	0	0	0	0	0	0	Biological Treatment

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (µg/l) Influent	*Concentration Range (µg/l) Effluent	**Average Concentration (µg/l) Influent	**Average Concentration (µg/l) Effluent	Comments Influent/Effluent
85. Tetrachloroethylene (continued)									
Paperboard From Wastepaper	15	15	1	0	0- 3	0	1	0	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Builders' Paper and Roofing Felt	9	--	1	--	0- 2	--	1	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Tissue Papers	3	3	0	3	0	8- 9	0	8	Primary Treatment
	3	3	0	0	0	0	0	0	Biological Treatment
Nonintegrated-Paperboard	6	6	3	0	2- 4	0	3	0	Biological Treatment
86. Toluene									
Dissolving Kraft	3	3	2	0	0- 1	0	1	0	Biological Treatment
Market Bleached Kraft	6	6	3	0	1- 5	0	3	0	Biological Treatment
BCT Bleached Kraft	9	9	6	0	0- 4	0	1	0	Biological Treatment
Alkaline-Fine	9	9	8	0	0- 180	0	23	0	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	0	1- 3	0	2	0	Biological Treatment
o Bag	6	6	4	0	0- 23	0	6	0	Biological Treatment
Semi-Chemical	6	6	3	3	3- 7	1- 4	5	2	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	3	0	2- 4	0	3	0	Biological Treatment
Dissolving Sulfite Pulp	4	4	1	0	0- 1	0	1	0	Biological Treatment
Papergrade Sulfite	12	12	9	7	0- 70	0- 66	23	14	Biological Treatment
Groundwood-Fine Papers	6	6	6	3	1- 63	0- 2	13	1	Biological Treatment
Deink									
o Fine Papers	3	3	3	0	11- 150	0	58	0	Biological Treatment
o Tissue Papers	3	3	3	1	10- 20	0- 1	15	1	Partial Final Effluent
	3	3	3	0	1- 4	0	3	0	Biological Treatment
o Newsprint	3	--	3	--	5- 20	--	14	--	POTW
Tissue From Wastepaper	6	6	5	2	0- 4	0- 8	2	2	Biological Treatment
	3	3	1	0	0- 2	0	1	0	Primary Treatment
Paperboard From Wastepaper	15	15	8	6	0- 39	0- 5	10	2	Biological Treatment
	3	3	3	3	1- 6	2- 5	4	3	Primary Treatment
Builders' Paper and Roofing Felt	9	--	8	--	0- 620	--	81	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (µg/l) Influent	*Concentration Range (µg/l) Effluent	**Average Concentration (µg/l) Influent	**Average Concentration (µg/l) Effluent	Comments Influent/Effluent
86. Toluene (continued)									
Nonintegrated-Fine Papers	6	6	0	3	0	1- 2	0	2	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Tissue Papers	3	3	3	3	2- 380	1- 15	130	6	Primary Treatment
	3	3	0	0	0	0	0	0	Biological Treatment
Nonintegrated-Lightweight Papers	3	3	2	2	0- 5	0- 2	2	1	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	1	0	0- 6	0	2	0	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Paperboard	6	6	3	4	0- 5	0- 1	2	1	Biological Treatment
Integrated Miscellaneous	12	12	6	7	0- 660	0- 150	99	66	Biological Treatment
Nonintegrated Miscellaneous	6	6	3	0	2- 6	0	4	0	Primary Treatment
	3	3	1	2	0- 3	0- 2	1	1	Primary w/Holding Pond
87. Trichloroethylene									
BCT Bleached Kraft	6	6	3	0	1- 2	0	2	0	Biological Treatment
Semi-Chemical	6	6	3	0	4- 15	0	9	0	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	2	0	0- 3	0	1	0	Biological Treatment
Papergrade Sulfite	12	12	3	0	2- 33	0	15	0	Biological Treatment
Deink									
o Fine Papers	3	3	3	3	130- 850	3- 11	493	7	Biological Treatment
o Tissue Papers	3	3	3	0	8- 13	0	11	0	Partial Final Effluent
	3	3	0	0	0	0	0	0	Biological Treatment
Paperboard From Wastepaper	15	15	5	0	0- 5	0	1	0	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Builders' Paper and Roofing Felt	9	--	5	--	0- 38	--	11	--	POTW
	3	3	1	0	0- 2	0	1	0	Primary Treatment
106. PCB-1242									
Deink									
o Fine Papers	3	3	1	0	0- 9.9	0	3	0	Biological Treatment

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (µg/l) Influent	*Concentration Range (µg/l) Effluent	**Average Concentration (µg/l) Influent	**Average Concentration (µg/l) Effluent	Comments Influent/Effluent
107. PCB-1254									
Unbleached Kraft and Semi-Chemical	6	6	3	3	0- <1	0- 2	1	1	Biological Treatment
Deink									
o Tissue Papers	3	3	1	0	0- 4	0	1	0	Biological Treatment
	3	3	0	0	0	0	0	0	Partial Final Effluent
Tissue From Wastepaper	6	6	4	3	0- <1	0- <1	1	1	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Paperboard From Wastepaper	15	15	1	1	0- <1	0- <1	<1	<1	Biological Treatment
	3	3	2	3	0- <1	<1	<1	<1	Primary Treatment
Builders' Paper and Roofing Felt	9	--	3	--	0- <1	--	<1	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
Nonintegrated-Fine Papers	3	3	2	0	0- <1	0	<1	0	Primary Treatment
	6	6	0	0	0	0	0	0	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	1	0	0- 28	0	9	0	Primary Treatment
	3	3	0	0	0	0	0	0	Biological Treatment
Integrated Miscellaneous	12	12	2	2	0- <1	0- <1	<1	<1	Biological Treatment
Nonintegrated Miscellaneous	6	6	1	0	0- 7	0	2	0	Primary Treatment
	3	3	0	0	0	0	0	0	Primary w/Holding Pond
108. PCB-1221	Not detected								
109. PCB-1232	Not detected								
110. PCB-1248									
Paperboard From Wastepaper	15	15	4	2	0- 10	0- <1	5	<1	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment
Builders' Paper and Roofing Felt	9	--	2	--	0- 7	--	4	--	POTW
	3	3	0	0	0	0	0	0	Primary Treatment
111. PCB 1260									
Deink									
o Tissue Papers	3	3	1	0	0- 3	0	1	0	Partial Final Effluent
	3	3	2	0	0- <1	0	<1	0	Biological Treatment
112. PCB 1016	Not detected								
119. Chromium									
Dissolving Kraft	3	3	3	3	5- 21	<2- 19	11	10	Biological Treatment
Market Bleached Kraft	6	6	6	6	7- 20	9- 73	13	26	Biological Treatment
BCT Bleached Kraft	9	9	9	9	4- 300	5- 240	85	55	Biological Treatment
Alkaline-Fine	9	9	9	9	<2- 76	2- 17	26	7	Biological Treatment

---

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (µg/l) Influent	*Concentration Range (µg/l) Effluent	**Average Concentration (µg/l) Influent	**Average Concentration (µg/l) Effluent	Comments Influent/Effluent
119. Chromium (continued)									
Unbleached Kraft									
o Linerboard	3	3	3	3	<2- 11	5- 8	7	7	Biological Treatment
o Bag	6	6	6	6	12- 26	5- 17	18	12	Biological Treatment
Semi-Chemical	6	6	6	6	18- 42	16- 23	29	19	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	8- 76	8- 47	29	19	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	18- 46	11-1,100	33	285	Biological Treatment
Papergrade Sulfite	12	12	12	12	6- 66	3- 16	23	8	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	1- 20	<1- 6	5	2	Biological Treatment
Deink									
o Fine Papers	3	3	3	3	29- 49	2- 9	42	5	Biological Treatment
o Tissue Papers	3	3	3	3	12- 18	6- 20	15	12	Partial Final Effluent
	3	3	3	3	4- 13	<1- 3	8	2	Biological Treatment
o Newsprint	3	--	3	--	<5- 54	--	29	--	POTW
Tissue From Wastepaper	6	6	6	6	<2- 63	<2- 28	20	13	Biological Treatment
	3	3	3	3	8- 27	5	17	5	Primary Treatment
Paperboard From Wastepaper	15	15	15	15	<2- 870	<2- 17	90	8	Biological Treatment
	3	3	3	3	180- 280	150- 195	230	165	Primary Treatment
Wastepaper-Molded Products	3	3	3	3	5- 14	3- 4	9	3	Biological Treatment
	3	--	3	--	<2- 8	--	5	--	POTW
Builders' Paper and Roofing Felt	9	--	9	--	24- 250	--	81	--	POTW
	3	3	3	3	290- 370	230- 350	337	290	Primary Treatment
Nonintegrated-Fine Papers	6	6	6	6	<1- 6	<1	3	<1	Biological Treatment
	3	3	3	3	1- 8	<2- 3	5	2	Primary Treatment
Nonintegrated-Tissue Papers	3	3	3	3	<1- 2	<2- 3	2	2	Biological Treatment
	3	3	3	3	22- 23	<2	23	<2	Primary Treatment
Nonintegrated-Lightweight Papers	3	3	3	2	2- 4	0- 3	3	2	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	<1- 1	<1- 2	1	1	Primary Treatment
	3	3	3	3	5- 8	<1- 4	6	3	Biological Treatment
Nonintegrated-Paperboard	6	6	6	6	5-1,800	<2- 13	675	6	Biological Treatment
Integrated Miscellaneous	12	12	12	12	<1- 12	<1- 18	5	5	Biological Treatment

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (μg/l) Influent	*Concentration Range (μg/l) Effluent	**Average Concentration (μg/l) Influent	**Average Concentration (μg/l) Effluent	Comments Influent/Effluent
119. Chromium (continued)									
Nonintegrated Miscellaneous	6	6	6	6	<1- 22	1- 20	11	5	Primary Treatment
	3	3	3	3	5- 39	<2- 2	18	2	Primary w/Holding Pond
120. Copper									
Dissolving Kraft	3	3	3	3	39- 42	<2- 42	40	17	Biological Treatment
Market Bleached Kraft	6	6	6	6	24- 37	4- 26	31	14	Biological Treatment
BCT Bleached Kraft	9	9	9	9	18- 70	<2- 42	46	17	Biological Treatment
Alkaline-Fine	9	9	9	9	9- 48	<1- 23	22	8	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	3	<2- 16	<2- 7	9	5	Biological Treatment
o Bag	6	6	6	6	12- 46	4- 15	24	9	Biological Treatment
Semi-Chemical	6	6	6	6	44- 120	5- 37	79	25	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	16- 64	2- 28	38	15	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	8- 35	6- 28	17	20	Biological Treatment
Papergrade Sulfite	12	12	12	12	<2- 220	8- 100	71	33	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	12- 62	5- 24	28	14	Biological Treatment
Deink									
o Fine Papers	3	3	3	3	42- 80	<2- 11	61	6	Biological Treatment
o Tissue Papers	3	3	3	3	22- 37	12- 40	29	22	Partial Final Effluent
	3	3	3	3	8- 21	<1	13	<1	Biological Treatment
o Newsprint	3	--	3	--	57- 89	--	76	--	POTW
Tissue From Wastepaper	6	6	6	6	24- 100	3- 110	55	47	Biological Treatment
	3	3	3	3	8- 15	<2- 18	13	8	Primary Treatment
Paperboard From Wastepaper	15	15	15	15	2- 650	<2- 42	96	15	Biological Treatment
	3	3	3	3	150- 188	143- 162	169	152	Primary
Wastepaper-Molded Products	3	3	3	3	3- 34	2- 5	16	4	Biological Treatment
	3	--	3	--	25- 44	--	37	--	POTW
Builders' Paper and Roofing Felt	9	--	9	--	30- 270	--	145	--	POTW
	3	3	3	3	185- 210	87- 97	202	93	Primary Treatment
Nonintegrated-Fine Papers	6	6	6	6	<1- 20	<1- 81	13	18	Biological Treatment
	3	3	3	3	6- 62	16- 26	43	19	Primary Treatment
Nonintegrated-Tissue Papers	3	3	3	3	17- 25	15- 33	22	25	Biological Treatment
	3	3	3	3	65- 88	13- 17	74	14	Primary Treatment

---

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples		Total Number Of Detected Analyses		*Concentration Range (µg/l)		**Average Concentration (µg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent/Effluent
120. Copper (continued)									
Nonintegrated-Lightweight Papers	3	3	3	2	10- 54	0- <10	37	4	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	14- 28	9- 10	19	10	Primary Treatment
	3	3	3	3	6- 120	6- 13	61	9	Biological Treatment
Nonintegrated-Paperboard	6	6	6	6	17- 300	<1- 10	78	4	Biological Treatment
Integrated Miscellaneous	12	12	12	12	2- 68	<1- 31	33	13	Biological Treatment
Nonintegrated Miscellaneous	6	6	6	6	4- 59	<1- 12	29	8	Primary Treatment
	3	3	3	3	60- 100	<2- 31	81	12	Primary w/Holding Pond
121. Cyanide									
Semi-Chemical	3	3	3	3	<10	<10	<10	<10	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	<10- 25	<10- 15	16	11	Biological Treatment
Deink									
o Fine Papers	3	3	3	3	32- 162	40- 95	108	72	Biological Treatment
o Tissue Papers	3	3	3	3	72- 110	170- 200	88	185	Primary Treatment
	3	3	3	3	<10	<10	<10	<10	Biological Treatment
o Newsprint	3	--	3	--	720-2,600	--	1,560	--	POTW
Tissue From Wastepaper	6	6	6	6	<10	<10	<10	<10	Biological Treatment
	3	3	3	3	<10	<10	<10	<10	Primary Treatment
Paperboard From Wastepaper	15	15	15	15	<10- 143	<10- 34	27	14	Biological Treatment
Wastepaper-Molded Products	3	3	3	3	29- 155	<10- 25	74	18	Primary Treatment
	3	3	3	3	<10	<10	<10	<10	Biological Treatment
	3	--	3	--	<10	--	<10	--	POTW
Builders' Paper and Roofing Felt	9	--	9	--	90-1,200	--	368	--	POTW
	3	3	3	3	25- 170	25- 190	108	117	Primary Treatment
Nonintegrated-Lightweight Papers	3	3	3	3	<10	<10	<10	<10	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	<10- 13	<10	11	<10	Biological Treatment
	3	3	0	0	0	0	0	0	Primary Treatment

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples		Total Number Of Detected Analyses		*Concentration Range (μg/l)		**Average Concentration (μg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent/Effluent
121. Cyanide (continued)									
Nonintegrated-Paperboard	6	6	6	6	<10-1,650	<10- 80	310	26	Biological Treatment
Integrated Miscellaneous	9	9	9	9	<10- 20	<10	11	10	Biological Treatment
Nonintegrated Miscellaneous	3	3	3	3	<10	<10	<10	<10	Primary w/Holding Pond
	6	6	0	0	0	0	0	0	Primary Treatment
122. Lead									
Dissolving Kraft	3	3	3	3	5- 7	<2- 15	6	8	Biological Treatment
Market Bleached Kraft	6	6	6	6	<1- 18	<1- 29	9	9	Biological Treatment
BCT Bleached Kraft	9	9	9	9	<1- 54	3- 45	17	18	Biological Treatment
Alkaline-Fine	9	9	9	9	<2- 10	<1- 15	6	6	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	3	<2- <20	2- 10	<13	5	Biological Treatment
o Bag	6	6	6	6	5- 24	2- 34	14	16	Biological Treatment
Semi-Chemical	6	6	6	6	47- 131	22- 50	95	35	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	9- 42	<2- 24	24	13	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	3	11- 25	0- 30	16	15	Biological Treatment
Papergrade Sulfite	12	12	12	12	<2- 86	<1- 42	25	11	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	4- 16	4- 19	9	8	Biological Treatment
Deink									
o Fine Papers	3	3	3	3	64- 320	24- 30	149	28	Biological Treatment
o Tissue Papers	3	3	3	3	<2- 44	<1- 22	22	10	Partial Final Effluent
	3	3	3	3	<1- 30	<1- 3	12	2	Biological Treatment
o Newsprint	3	--	3	--	28- 260	--	163	--	POTW
Tissue From Wastepaper	6	6	6	6	4- 120	4- 120	44	38	Biological Treatment
	3	3	3	3	<2- 8	<2- 3	5	2	Primary Treatment
Paperboard From Wastepaper	15	15	15	15	<2- 900	<2- 140	137	23	Biological Treatment
	3	3	3	3	135- 230	60- 130	198	92	Primary Treatment
Wastepaper-Molded Products	3	3	3	3	2- 33	7- 18	22	12	Biological Treatment
	3	--	3	--	<2- <20	--	<13	--	POTW
Builders' Paper and Roofing Felt	9	--	9	--	36- 880	--	264	--	POTW
	3	3	3	3	210- 360	50- 190	273	137	Primary Treatment

---

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (µg/l) Influent	*Concentration Range (µg/l) Effluent	**Average Concentration (µg/l) Influent	**Average Concentration (µg/l) Effluent	Comments Influent/Effluent
122. Lead (continued)									
Nonintegrated-Fine Papers	6	6	6	6	<1- 8	<1- 5	3	3	Biological Treatment
	3	3	3	3	<1- 10	6- 21	5	13	Primary Treatment
Nonintegrated-Tissue Papers	3	3	3	3	<1- <2	<2	<2	<2	Biological Treatment
	3	3	3	3	<2- 32	<2	14	<2	Primary Treatment
Nonintegrated-Lightweight Papers	3	3	3	2	5- 12	0- <1	9	<1	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	<1- 22	<1- 1	8	1	Primary Treatment
	3	3	3	3	1- 6	<2- 10	4	6	Biological Treatment
Nonintegrated-Paperboard	6	6	6	6	<2-9,000	<2- 20	3,334	9	Biological Treatment
Integrated Miscellaneous	12	12	12	12	<1- 40	<2- 26	12	7	Biological Treatment
Nonintegrated Miscellaneous	6	6	6	6	<2- 40	<2- 10	16	7	Primary Treatment
	3	3	3	3	<2- 30	<2	11	<2	Primary w/Holding Pond
123. Mercury									
Dissolving Kraft	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Market Bleached Kraft	6	6	6	6	<0.5	<0.5	<0.5	<0.5	Biological Treatment
BCT Bleached Kraft	9	9	9	9	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Alkaline-Fine	9	9	9	9	<0.5	<0.5- 0.9	<0.5	0.5	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Biological Treatment
o Bag	6	6	6	6	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Semi-Chemical	6	6	6	6	<0.5- 0.6	<0.5	0.5	<0.5	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	5	<0.5	0- <0.5	<0.5	<0.5	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Papergrade Sulfite	12	12	12	12	<0.5- 1.8	<0.5- 1.5	0.7	0.7	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Deink									
o Fine Papers	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Biological Treatment
o Tissue Papers	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Partial Final Effluent
	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Biological Treatment
o Newsprint	3	--	3	--	<0.5- 2.4	--	1.2	--	POTW
Tissue From Wastepaper	3	3	3	3	0.6- 1.2	<0.5- 0.9	1.0	0.8	Primary Treatment
	6	6	6	6	<0.5- 1.2	<0.5- 2.0	0.6	0.8	Biological Treatment

---

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples		Total Number Of Detected Analyses		*Concentration Range (µg/l)		**Average Concentration (µg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent/Effluent
123. Mercury (continued)									
Paperboard From Wastepaper	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Primary Treatment
	15	15	15	15	<0.5- 1.0	<0.5- 2.2	0.6	0.7	Biological Treatment
Wastepaper-Molded Products	3	--	3	--	<0.5	--	<0.5	--	POTW
	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Builders' Paper and Roofing Felt	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Primary Treatment
	9	--	9	--	<0.5- 1.0	--	0.6	--	POTW
Nonintegrated-Fine Papers	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Primary Treatment
	6	6	6	6	<0.5- 0.8	<0.5- 0.7	0.6	0.6	Biological Treatment
Nonintegrated-Tissue Papers	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Biological Treatment
	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Primary Treatment
Nonintegrated-Lightweight Papers	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Primary Treatment
	3	3	3	3	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Nonintegrated-Paperboard	6	6	6	6	<0.5	<0.5	<0.5	<0.5	Biological Treatment
Integrated Miscellaneous	12	12	12	12	<0.5- 0.6	<0.5- 0.6	0.5	0.5	Biological Treatment
Nonintegrated Miscellaneous	3	3	3	3	<0.5	<0.5- 0.6	<0.5	0.6	Primary w/Holding Pond
	6	6	6	6	<0.5- 1.5	<0.5	0.8	<0.5	Primary Treatment
124. Nickel									
Dissolving Kraft	3	3	3	3	<2- 8	2- 15	5	10	Biological Treatment
Market Bleached Kraft	6	6	6	6	16- 59	8- 18	31	14	Biological Treatment
BCT Bleached Kraft	9	9	9	9	<2- 120	<2- 30	36	12	Biological Treatment
Alkaline-Fine	9	9	9	9	<2- 33	1- 16	16	8	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	3	<2- 9	3- 6	5	5	Biological Treatment
o Bag	6	6	6	6	<2- 12	<2- 10	6	5	Biological Treatment
Semi-Chemical	6	6	6	6	<2- 22	6- 17	12	10	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	<2- 29	<2- 12	10	5	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	8- 45	<2- 269	25	130	Biological Treatment
Papergrade Sulfite	12	12	12	12	3- 48	<2- 18	15	9	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	<2- 8	<1- 10	5	5	Biological Treatment

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples Influent	Total Number Of Samples Effluent	Total Number Of Detected Analyses Influent	Total Number Of Detected Analyses Effluent	*Concentration Range (μg/l) Influent	*Concentration Range (μg/l) Effluent	**Average Concentration (μg/l) Influent	**Average Concentration (μg/l) Effluent	Comments Influent/Effluent
124. Nickel (continued)									
Deink									
o Fine Papers	3	3	3	3	5- 20	<2- 7	15	4	Biological Treatment
o Tissue Papers	3	3	3	3	4- 9	<2- 6	6	3	Partial Final Effluent
	3	3	3	3	<1- 4	<1- 4	2	2	Biological Treatment
o Newsprint	3	--	3	--	5- 30	--	15	--	POTW
Tissue From Wastepaper	3	3	3	3	5- 25	2- 6	15	3	Primary Treatment
	6	6	6	6	2- 92	3- 25	21	13	Biological Treatment
Paperboard From Wastepaper	3	3	3	3	42- 139	33- 69	84	56	Primary Treatment
	15	15	15	15	<2- 130	<2- 44	37	14	Biological Treatment
Wastepaper-Molded Products	3	--	3	--	<2- 2	--	2	--	POTW
	3	3	3	3	10- 48	<1- 5	23	3	Biological Treatment
Builders' Paper and Roofing Felt	3	3	3	3	84- 160	100- 140	115	120	Primary Treatment
	9	--	9	--	12- 65	--	40	--	POTW
Nonintegrated-Fine Papers	3	3	3	3	<2- 12	<2	5	<2	Primary Treatment
	6	6	6	6	<1- 10	<1- 13	5	6	Biological Treatment
Nonintegrated-Tissue Papers	3	3	3	3	<2	<2- 3	<2	2	Biological Treatment
	3	3	3	3	<2- 2	<2	2	<2	Primary Treatment
Nonintegrated-Lightweight Papers	3	3	3	3	<2	0- <2	<2	<1	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	<1	<1- 3	<1	2	Primary Treatment
	3	3	3	3	<1- 3	<1- <2	2	<1	Biological Treatment
Nonintegrated-Paperboard	6	6	6	6	<2- 29	2- 10	13	5	Biological Treatment
Integrated Miscellaneous	12	12	12	12	<2- 9	1- 12	5	5	Biological Treatment
Nonintegrated Miscellaneous	3	3	3	3	<2- 8	<2- 7	4	4	Primary w/Holding Pond
	6	6	6	6	8- 44	<2- 15	28	6	Primary Treatment
128. Zinc									
Dissolving Kraft	3	3	3	3	73- 78	44- 51	75	48	Biological Treatment
Market Bleached Kraft	6	6	6	6	100- 185	46- 91	154	61	Biological Treatment
BCT Bleached Kraft	9	9	9	9	74- 200	45- 360	138	110	Biological Treatment
Alkaline-Fine	9	9	9	9	67- 290	36- 208	149	72	Biological Treatment

* Range for those mills where pollutant was detected in influent or effluent.

** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-31 (Continued)

Toxic Pollutant/Subcategory	Total Number Of Samples		Total Number Of Detected Analyses		*Concentration Range (µg/l)		**Average Concentration (µg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent/Effluent
128. Zinc (continued)									
Unbleached Kraft									
o Linerboard	3	3	3	3	37- 120	27- 100	71	67	Biological Treatment
o Bag	6	6	6	6	41- 230	16- 150	136	81	Biological Treatment
Semi-Chemical	6	6	6	6	78- 230	31- 120	143	69	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	24- 58	15- 46	40	25	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	42- 85	37- 77	70	60	Biological Treatment
Papergrade Sulfite	12	12	12	12	5- 150	25- 420	104	118	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	53- 90	9- 86	74	45	Biological Treatment
Deink									
o Fine Papers	3	3	3	3	97- 352	30- 38	206	33	Biological Treatment
o Tissue Papers	3	3	3	3	170- 260	51- 82	200	71	Partial Final Effluent
	3	3	3	3	30- 46	5- 36	40	19	Biological Treatment
o Newsprint	3	--	3	--	300- 375	--	335	--	POTW
Tissue From Wastepaper	3	3	3	3	52- 59	22- 33	54	27	Primary Treatment
	6	6	6	6	31-3,560	<5- 183	677	88	Biological Treatment
Paperboard From Wastepaper	3	3	3	3	1,100-1,600	1,000-1,900	1,433	1,500	Primary Treatment
	15	15	15	15	26-4,720	40- 210	1,206	113	Biological Treatment
Wastepaper-Molded Products	3	--	3	--	120- 330	--	200	--	POTW
	3	3	3	3	262- 465	26- 73	392	52	Biological Treatment
Builders' Paper and Roofing Felt	3	3	3	3	2,500-3,000	1,900-2,900	2,800	2,400	Primary Treatment
	9	--	9	--	5-2,100	--	999	--	POTW
Nonintegrated-Fine Papers	3	3	3	3	49- 91	75- 160	71	118	Primary Treatment
	6	6	6	6	6- 185	<3- 35	55	18	Biological Treatment
Nonintegrated-Tissue Papers	3	3	3	3	52,000-54,000	60- 140	53,300	88	Biological Treatment
	3	3	3	3	46- 160	19- 29	92	23	Primary Treatment
Nonintegrated-Lightweight Papers	3	3	3	3	12- 22	0- 8	16	4	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	11- 15	9- 17	13	12	Primary Treatment
	3	3	3	3	118- 193	40- 66	159	56	Biological Treatment
Nonintegrated-Paperboard	6	6	6	6	72-2,050	<5- 210	710	72	Biological Treatment
Integrated Miscellaneous	12	12	12	12	12- 710	15-1,800	259	443	Biological Treatment
Nonintegrated Miscellaneous	3	3	3	3	10- 48	1- 7	25	3	Primary w/Holding Pond
	6	6	6	6	40-3,840	<2-1,000	802	217	Primary Treatment

---

* Range for those mills where pollutant was detected in influent or effluent.
** Average for those mills where pollutant was detected in influent or effluent.

TABLE V-32

SUMMARY OF VERIFICATION PROGRAM ANALYSIS RESULTS FOR NONCONVENTIONAL POLLUTANTS

Toxic Pollutant/ Subcategory	Total Number of Samples Influent	Total Number of Samples Effluent	Total Number of Detected Analyses Influent	Total Number of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments
130. Abietic Acid									
Dissolving Kraft	3	3	3	3	8600-18000	100-2500	11800	1467	Biological Treatment
Market Bleached Kraft	6	6	6	3	6- 390	0-1800	178	767	Biological Treatment
BCT Bleached Kraft	9	9	7	6	0- 2700	0- 520	1041	119	Biological Treatment
Alkaline-Fine	9	9	6	3	190- 1100	0- 11	470	3	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	2	350- 1200	0- 21	753	10	Biological Treatment
o Bag	6	6	6	6	3700-12000	30- 250	6983	165	Biological Treatment
Semi-Chemical	6	6	3	3	220- 290	35- 43	257	39	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	650- 2000	580-1000	1392	710	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	3	94- 5200	0- 940	1949	383	Biological Treatment
Papergrade Sulfite	12	12	8	9	0- 490	8- 340	137	76	Biological Treatment
Groundwood-Fine Papers	6	6	6	4	11- 600	0- 26	182	7	Biological Treatment
Deink									
o Fine Papers	3	3	3	2	700- 990	0- 31	837	12	Biological Treatment
o Newsprint	3	--	3	--	2300- 4100	-- --	3467	--	POTW
o Tissue Papers	3	3	3	3	370- 680	50- 140	557	97	Partial Final Effluent
	3	3	3	3	330- 740	40- 90	513	72	Biological Treatment
Tissue From Wastepaper	6	6	4	0	0- 150	0 --	54	0	Biological Treatment
	3	3	3	3	120- 260	35- 140	203	84	Primary Treatment
Paperboard From Wastepaper	15	15	15	6	18- 1900	0- 96	651	19	Biological Treatment
	3	3	3	0	120- 710	0 --	407	0	Primary Treatment
Wastepaper-Molded Products	3	3	3	1	190- 250	0- 21	210	7	Biological Treatment
	3	--	3	--	540- 680	-- --	633	--	POTW
Builders' Paper and Roofing Felt	9	--	9	--	930-14000	-- --	7559	--	POTW
	3	3	0	0	0 --	0 --	0	0	Primary Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples Influent	Total Number of Samples Effluent	Total Number of Detected Analyses Influent	Total Number of Detected Analyses Effluent	Concentration Range (μg/l) Influent	Concentration Range (μg/l) Effluent	Average Concentration (μg/l) Influent	Average Concentration (μg/l) Effluent	Comments
130. Abietic Acid (continued)									
Nonintegrated-Fine Papers	6	6	5	2	0- 660	0- 18	207	6	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Tissue Papers	3	3	3	0	39- 75	0 --	53	0	Primary Treatment
	3	3	0	0	0 --	0 --	0	0	Biological Treatment
Nonintegrated-Paperboard	6	6	5	0	0- 1800	0 --	748	0	Biological Treatment
Integrated Miscellaneous	12	12	8	6	0- 4100	0- 160	1029	61	Biological Treatment
Nonintegrated Miscellaneous	6	6	3	1	140- 240	0- 24	177	8	Primary Treatment
	3	3	0	0	0 --	0 --	0	0	Primary w/Holding Pond
131. Dehydroabietic Acid									
Dissolving Kraft	3	3	3	2	3000- 5200	0- 800	3500	520	Biological Treatment
Market Bleached Kraft	6	6	6	6	10- 560	2-1000	232	431	Biological Treatment
BCT Bleached Kraft	9	9	9	9	280- 1400	48- 310	861	123	Biological Treatment
Alkaline-Fine	9	9	6	6	140- 430	3- 7	273	5	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	3	330- 640	6- 15	470	11	Biological Treatment
o Bag	6	6	6	6	950-27600	30- 200	7142	85	Biological Treatment
Semi-Chemical	6	6	6	4	79- 230	0- 27	168	14	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	230- 1000	200- 330	607	235	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	190- 1870	6- 400	1000	171	Biological Treatment
Papergrade Sulfite	12	12	12	9	2- 1300	0- 950	423	246	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	28- 360	10- 50	148	26	Biological Treatment
Deink									
o Fine Papers	3	3	3	3	1400- 2900	42- 62	2267	49	Biological Treatment
o Newsprint	3	--	3	--	2600- 4800	-- --	3700	--	POTW
o Tissue Papers	3	3	3	3	2200- 4700	130- 630	3267	343	Partial Final Effluent
	3	3	3	3	1400- 2400	180- 300	1833	253	Biological Treatment
Tissue From Wastepaper	6	6	6	4	150- 840	0- 37	372	20	Biological Treatment
	3	3	3	3	220- 650	160- 300	417	250	Primary Treatment
Paperboard From Wastepaper	15	15	15	12	130- 920	0- 140	479	55	Biological Treatment
	3	3	3	3	410- 530	59- 120	467	96	Primary Treatment
Wastepaper-Molded Products	3	3	3	3	340- 530	2- 170	453	61	Biological Treatment
	3	--	3	--	550- 620	-- --	573	--	POTW

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples Influent	Total Number of Samples Effluent	Total Number of Detected Analyses Influent	Total Number of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments
131. Dehydroabietic Acid (continued)									
Builders' Paper and Roofing Felt	9	--	9	--	670- 6000	-- --	2199	--	POTW
	3	3	3	3	110- 170	60- 200	143	117	Primary Treatment
Nonintegrated-Fine Papers	6	6	6	6	58- 720	17- 66	433	45	Biological Treatment
	3	3	3	3	160- 660	49- 150	483	93	Primary Treatment
Nonintegrated-Tissue Papers	3	3	3	3	190- 230	85- 112	213	98	Primary Treatment
	3	3	0	0	0 --	0 --	0	0	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	2	0	0- 50	0 --	33	0	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Paperboard	6	6	6	4	110- 780	0- 180	413	64	Biological Treatment
Integrated Miscellaneous	12	12	10	9	0- 2000	0- 310	585	96	Biological Treatment
Nonintegrated Miscellaneous	6	6	6	4	2- 400	0- 220	174	67	Primary Treatment
	3	3	3	3	10- 16	160- 270	14	200	Primary w/Holding Pond
132. Isopimaric Acid									
Dissolving Kraft	3	3	3	3	660- 1300	160- 590	887	380	Biological Treatment
Market Bleached Kraft	6	6	3	3	66- 180	230- 500	115	407	Biological Treatment
BCT Bleached Kraft	9	9	8	7	0- 250	0- 86	107	21	Biological Treatment
Alkaline-Fine	9	9	6	3	54- 110	0- 3	74	1	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	2	78- 450	0- 10	283	6	Biological Treatment
o Bag	6	6	6	3	380- 1600	0- 32	770	15	Biological Treatment
Semi-Chemical	6	6	6	3	23- 48	0- 16	34	7	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	260- 850	140- 260	547	187	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	3	15- 1760	0- 230	774	115	Biological Treatment
Papergrade Sulfite	12	12	6	7	0- 230	0- 84	62	17	Biological Treatment
Groundwood-Fine Papers	6	6	4	5	0- 110	0- 6	29	3	Biological Treatment
Deink									
o Fine Papers	3	3	3	3	420- 900	1- 9	587	5	Biological Treatment
o Newsprint	3	--	3	--	240- 690	-- --	510	--	POTW
o Tissue Papers	3	3	3	3	110- 180	14- 24	150	18	Partial Final Effluent
	3	3	3	3	120- 270	1- 20	193	13	Biological Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples Influent	Total Number of Samples Effluent	Total Number of Detected Analyses Influent	Total Number of Detected Analyses Effluent	Concentration Range (μg/l) Influent	Concentration Range (μg/l) Effluent	Average Concentration (μg/l) Influent	Average Concentration (μg/l) Effluent	Comments
132. Isopimaric Acid (continued)									
Tissue From Wastepaper	6	6	3	0	21- 43	0 --	32	0	Biological Treatment
	3	3	3	0	13- 45	0 --	28	0	Primary Treatment
Paperboard From Wastepaper	15	15	15	4	12- 600	0- 15	128	3	Biological Treatment
	3	3	3	1	65- 100	0- 23	84	8	Primary Treatment
Wastepaper-Molded Products	3	3	3	0	41- 56	0 --	48	0	Biological Treatment
	3	--	3	--	80- 120	-- --	94	--	POTW
Builders' Paper and Roofing Felt	9	--	9	--	160- 3000	-- --	1164	--	POTW
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Fine Papers	6	6	6	0	8- 140	0 --	39	0	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Tissue Papers	3	3	3	1	23- 46	0- 6	37	2	Primary Treatment
	3	3	0	0	0 --	0 --	0	0	Biological Treatment
Nonintegrated-Paperboard	6	6	6	0	8- 190	0 --	62	0	Biological Treatment
Integrated Miscellaneous	12	12	8	6	0- 1400	0- 77	374	31	Biological Treatment
Nonintegrated Miscellaneous	6	6	3	2	69- 110	0- 22	84	11	Primary Treatment
	3	3	0	0	0 --	0 --	0	0	Primary w/Holding Pond
133. Pimaric Acid									
Dissolving Kraft	3	3	3	3	970- 1900	620- 790	1357	710	Biological Treatment
Market Bleached Kraft	6	6	3	3	120- 200	320- 530	157	430	Biological Treatment
BCT Bleached Kraft	9	9	7	6	0- 350	0- 74	115	22	Biological Treatment
Alkaline-Fine	9	9	6	0	20- 93	0 --	63	0	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	1	38- 51	0- 3	43	1	Biological Treatment
o Bag	6	6	6	6	420- 2500	10- 60	1168	32	Biological Treatment
Semi-Chemical	6	6	4	2	0- 130	0- 13	36	4	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	37- 370	39- 190	152	106	Biological Treatment
Dissolving Sulfite Pulp	4	4	3	3	180- 450	20- 38	277	31	Biological Treatment
Papergrade Sulfite	12	12	2	1	0- 64	0- 52	25	17	Biological Treatment
Groundwood-Fine Papers	6	6	3	1	31- 150	0- 15	76	5	Biological Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples		Total Number of Detected Analyses		Concentration Range (µg/l)		Average Concentration (µg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
133. Pimaric Acid (continued)									
Deink									
o Fine Papers	3	3	3	0	92- 160	0 --	127	0	Biological Treatment
o Newsprint	3	--	3	--	220- 310	-- --	257	--	POTW
o Tissue Papers	3	3	3	0	31- 52	0 --	39	0	Partial Final Effluent
	3	3	3	0	36- 160	0 --	80	0	Biological Treatment
Tissue From Wastepaper	6	6	3	0	2- 18	0 --	12	0	Biological Treatment
	3	3	3	0	19- 78	0 --	43	0	Primary Treatment
Paperboard From Wastepaper	15	15	11	0	0- 210	0 --	78	0	Biological Treatment
	3	3	3	0	35- 48	0 --	41	0	Primary Treatment
Wastepaper-Molded Products	3	3	3	0	48- 64	0 --	57	0	Biological Treatment
	3	--	0	--	0 --	-- --	0	--	POTW
Builders' Paper and Roofing Felt	9	--	9	--	130- 1600	-- --	576	--	POTW
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Fine Papers	6	6	5	0	0- 40	0 --	19	0	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Tissue Papers	3	3	2	0	0- 15	0 --	10	0	Primary Treatment
	3	3	0	0	0 --	0 --	0	0	Biological Treatment
Nonintegrated-Paperboard	6	6	3	0	22- 29	0 --	25	0	Biological Treatment
Integrated Miscellaneous	12	12	4	4	0- 1300	0- 48	384	25	Biological Treatment
Nonintegrated Miscellaneous	6	6	3	0	40- 65	0 --	54	0	Primary Treatment
	3	3	0	0	0 --	0 --	0	0	Primary w/Holding Pond
134. Oleic Acid									
Dissolving Kraft	3	3	3	2	3000- 4500	0- 810	3667	333	Biological Treatment
Market Bleached Kraft	6	6	6	6	250- 520	22- 250	345	153	Biological Treatment
BCT Bleached Kraft	9	9	7	4	0- 2900	0- 92	1084	17	Biological Treatment
Alkaline-Fine	9	9	6	6	16- 970	15- 130	276	41	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	3	160- 500	4- 65	337	38	Biological Treatment
o Bag	6	6	6	3	1700- 6700	0- 150	3133	70	Biological Treatment
Semi-Chemical	6	6	6	4	21- 200	0- 56	115	33	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	210- 1200	130- 800	618	407	Biological Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples Influent	Total Number of Samples Effluent	Total Number of Detected Analyses Influent	Total Number of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments
134. Oleic Acid (continued)									
Dissolving Sulfite Pulp	4	4	4	4	28- 1860	31- 120	1157	81	Biological Treatment
Papergrade Sulfite	12	12	12	9	14- 330	0- 220	129	70	Biological Treatment
Groundwood-Fine Papers	6	6	6	4	17- 450	0- 46	174	23	Biological Treatment
Deink									
o Fine Papers	3	3	3	3	500- 1200	30- 75	967	49	Biological Treatment
o Newsprint	3	--	3	--	1300- 1500	-- --	1367	--	POTW
o Tissue Papers	3	3	3	3	190- 710	470- 750	400	590	Partial Final Effluent
	3	3	3	3	310- 560	220- 280	410	243	Biological Treatment
Tissue From Wastepaper	6	6	6	5	98- 270	0- 310	183	193	Biological Treatment
	3	3	3	1	81- 200	0- 74	147	25	Primary Treatment
Paperboard From Wastepaper	15	15	15	10	34- 940	0- 310	339	78	Biological Treatment
	3	3	3	0	180- 450	0 --	290	0	Primary Treatment
Wastepaper-Molded Products	3	3	3	3	460- 540	5- 80	493	48	Biological Treatment
	3	--	3	--	340- 360	-- --	353	--	POTW
Builders' Paper and Roofing Felt	9	--	9	--	830- 3500	-- --	2237	--	POTW
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Fine Papers	6	6	3	0	55- 80	0 --	65	0	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Tissue Papers	3	3	3	2	210- 290	0- 61	260	27	Primary Treatment
	3	3	3	2	4- 29	0- 47	13	27	Biological Treatment
Nonintegrated-Paperboard	6	6	3	0	250- 270	0 --	260	0	Biological Treatment
Integrated Miscellaneous	12	12	11	5	0- 1900	0- 230	450	38	Biological Treatment
Nonintegrated Miscellaneous	6	6	3	2	48- 68	0- 13	55	8	Primary Treatment
	3	3	0	0	0 --	0 --	0	0	Primary w/Holding Pond
135. Linoleic Acid									
Dissolving Kraft	3	3	3	1	2200- 3900	0- 510	2900	170	Biological Treatment
Market Bleached Kraft	6	6	6	6	220- 2300	26- 100	792	64	Biological Treatment
BCT Bleached Kraft	9	9	6	0	180- 1300	0 --	762	0	Biological Treatment
Alkaline-Fine	9	9	3	3	170- 470	2- 7	283	4	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	0	150- 270	0 --	203	0	Biological Treatment
o Bag	6	6	6	0	610- 1700	0 --	958	0	Biological Treatment
Semi-Chemical	6	6	3	3	66- 160	13- 17	122	14	Biological Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples		Total Number of Detected Analyses		Concentration Range (µg/l)		Average Concentration (µg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
135. Linoleic Acid (continued)									
Unbleached Kraft and Semi-Chemical	6	6	6	3	98- 820	0- 170	441	59	Biological Treatment
Dissolving Sulfite Pulp	4	4	3	1	240- 1000	0- 25	510	8	Biological Treatment
Papergrade Sulfite	12	12	9	4	8- 270	0- 160	63	34	Biological Treatment
Groundwood-Fine Papers	6	6	3	3	180- 620	11- 150	337	72	Biological Treatment
Deink									
o Fine Papers	3	3	3	0	260- 650	0 --	470	0	Biological Treatment
o Newsprint	3	--	3	--	160- 1200	-- --	750	--	POTW
o Tissue Papers	3	3	3	0	38- 86	0 --	55	0	Partial Final Effluent
	3	3	3	0	74- 320	0 --	178	0	Biological Treatment
Paperboard From Wastepaper	15	15	5	0	0- 87	0 --	63	0	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Wastepaper Molded Products	3	3	3	0	170- 240	0 --	207	0	Biological Treatment
	3	--	3	--	110- 150	-- --	123	--	POTW
Builders' Paper and Roofing Felt	9	--	8	--	0- 3600	-- --	897	--	POTW
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Fine Papers	6	6	1	0	0- 200	0 --	67	0	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	0	1	0 --	0- 9	0	3	Biological Treatment
Integrated Miscellaneous	12	12	7	1	0- 830	0- 6	290	1	Biological Treatment
Nonintegrated Miscellaneous	6	6	2	0	0- 77	0 --	33	0	Primary Treatment
	3	3	0	0	0 --	0 --	0	0	Primary w/Holding Pond
136. Linolenic Acid									
Market Bleached Kraft	6	6	3	3	22- 210	40 53	126	47	Biological Treatment
Alkaline-Fine	9	9	3	0	42- 93	0 --	71	0	Biological Treatment
Unbleached Kraft									
o Bag	6	6	3	0	670- 3170	0 --	1543	0	Biological Treatment
Semi-Chemical	6	6	3	3	54- 140	31- 39	98	35	Biological Treatment
Papergrade Sulfite	12	12	5	0	0- 130	0 --	58	0	Biological Treatment
Groundwood-Fine Papers	6	6	3	0	120- 480	0 --	250	0	Biological Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples		Total Number of Detected Analyses		Concentration Range (µg/l)		Average Concentration (µg/l)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
136. Linolenic Acid (continued)									
Deink									
o Fine Papers	3	3	3	3	85- 330	79- 120	212	99	Biological Treatment
o Newsprint	3	--	3	--	<100- <200	-- --	<167	--	POTW
Paperboard From Wastepaper	15	15	3	1	55- 83	0- 14	69	5	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
Builders' Paper and Roofing Felt	9	--	3	--	84- 170	-- --	138	--	POTW
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
137. Epoxystearic Acid									
Dissolving Kraft	3	3	3	0	800- 850	0 --	817	0	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	3	2	99- 380	0- 190	266	113	Biological Treatment
Papergrade Sulfite	12	12	1	1	0- 120	0- 20	40	7	Biological Treatment
Paperboard From Wastepaper	15	15	3	0	310- 490	0 --	413	0	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Primary Treatment
139. Chlorodehydroabietic Acid									
Dissolving Kraft	3	3	3	3	1300- 1600	330- 700	1433	473	Biological Treatment
Market Bleached Kraft	6	6	4	3	0- 120	0- 140	50	42	Biological Treatment
BCT Bleached Kraft	9	9	5	5	0- 190	0- 31	78	11	Biological Treatment
Alkaline-Fine	9	9	9	0	2- 240	0 --	44	0	Biological Treatment
Semi-Chemical	6	6	0	3	0 --	3- 18	0	9	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	3	45- 360	0- 241	161	108	Biological Treatment
Papergrade Sulfite	12	12	6	3	8- 340	0- 93	123	39	Biological Treatment
Deink									
o Fine Papers	3	3	3	0	330- 730	0 --	467	0	Biological Treatment
o Tissue Papers	3	3	3	2	18- 28	0- 26	24	14	Partial Final Effluent
	3	3	0	0	0 --	0 --	0	0	Biological Treatment
Integrated Miscellaneous	12	12	4	1	0- 84	0- 3	33	1	Biological Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples Influent	Total Number of Samples Effluent	Total Number of Detected Analyses Influent	Total Number of Detected Analyses Effluent	Concentration Range (μg/l) Influent	Concentration Range (μg/l) Effluent	Average Concentration (μg/l) Influent	Average Concentration (μg/l) Effluent	Comments
140. Dichlorodehydroabietic Acid									
Market Bleached Kraft	6	6	3	3	30- 86	11- 65	57	39	Biological Treatment
BCT Bleached Kraft	9	9	2	1	0- 15	0- 4	3	1	Biological Treatment
Alkaline-Fine	9	9	2	0	0- 32	0 --	6	0	Biological Treatment
Semi-Chemical	6	6	0	2	0 --	0- 30	0	13	Biological Treatment
Dissolving Sulfite Pulp	4	4	1	0	0- 280	0 --	93	0	Biological Treatment
Papergrade Sulfite	12	12	3	1	0- 5	0- 3	2	1	Biological Treatment
Deink									
o Fine Papers	3	3	2	0	0- 12	0 --	6	0	Biological Treatment
Integrated Miscellaneous	12	12	1	0	0- 5	0 --	2	0	Biological Treatment
141. Trichloroguaiacol									
Market Bleached Kraft	6	6	3	0	15- 21	0 --	18	0	Biological Treatment
BCT Bleached Kraft	9	9	1	0	0- 1	0 --	1	0	Biological Treatment
Alkaline-Fine	9	9	4	1	0- 9	0- 2	4	1	Biological Treatment
Dissolving Sulfite Pulp	4	4	1	0	6 --	0 --	6	0	Biological Treatment
Papergrade Sulfite	12	12	3	2	2- 6	0- 3	4	2	Biological Treatment
Deink									
o Fine Papers	3	3	2	3	0- 28	10- 17	14	14	Biological Treatment
142. Tetrachloroguaiacol									
Market Bleached Kraft	6	6	6	0	4- 23	0 --	11	0	Biological Treatment
BCT Bleached Kraft	9	9	6	1	2- 17	0- 1	8	1	Biological Treatment
Alkaline-Fine	9	9	9	5	4- 17	0- 8	7	3	Biological Treatment
Dissolving Sulfite Pulp	4	4	1	1	4 --	2 --	4	2	Biological Treatment
Papergrade Sulfite	12	12	1	0	0- 2	0 --	1	0	Biological Treatment
Deink									
o Fine Papers	3	3	3	3	4- 16	6- 13	8	9	Biological Treatment
143. Xylenes									
Alkaline-Fine	9	9	2	0	0- 8	0 --	4	0	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	0	22- 44	0 --	33	0	Biological Treatment
o Bag	6	6	3	0	8- 10	0 --	9	0	Biological Treatment
Semi-Chemical	6	6	2	3	0- 4	1- 3	2	2	Biological Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples Influent	Total Number of Samples Effluent	Total Number of Detected Analyses Influent	Total Number of Detected Analyses Effluent	Concentration Range (µg/l) Influent	Concentration Range (µg/l) Effluent	Average Concentration (µg/l) Influent	Average Concentration (µg/l) Effluent	Comments
143. Xylenes (continued)									
Unbleached Kraft and Semi-Chemical	6	6	3	0	19- 27	0 --	22	0	Biological Treatment
Papergrade Sulfite	12	12	3	0	0- 4	0 --	1	0	Biological Treatment
Deink									
o Fine Papers	3	3	1	0	0- 20	0 --	7	0	Biological Treatment
o Newsprint	3	--	3	--	5- 110	-- --	46	0	POTW
o Tissue Papers	3	3	2	0	0- 9	0 --	5	0	Biological Treatment
	3	3	0	0	0 --	0 --	0	0	Partial Final Effluent
Tissue From Wastepaper	6	6	5	1	0- 140	0- 13	28	2	Biological Treatment
	3	3	1	0	0- 31	0 --	10	0	Primary Treatment
Paperboard From Wastepaper	15	15	5	0	0- 6	0 --	3	0	Biological Treatment
	3	3	1	0	0- 3	0 --	1	0	Primary Treatment
Builders' Paper and Roofing Felt	9	--	9	--	3- 63	-- --	18	--	POTW
	3	3	2	2	0- 28	0- 32	14	16	Primary Treatment
Nonintegrated-Tissue Papers	3	3	3	3	140-37000	160-1600	13547	800	Primary Treatment
	3	3	0	0	0 --	0 --	0	0	Biological Treatment
Nonintegrated-Lightweight Papers	3	3	2	0	0- 8	0 --	5	0	Biological Treatment
Nonintegrated-Paperboard	6	6	3	3	5- 14	1- 4	8	3	Biological Treatment
Integrated Miscellaneous	12	12	7	1	0- 160	0- 4	23	1	Biological Treatment
Nonintegrated Miscellaneous	6	6	3	3	7- 10	6- 340	9	147	Primary Treatment
	3	3	0	0	0 --	0 --	0	0	Primary w/Holding Pond
149. Color					(Platinum Cobalt Units)		(Platinum Cobalt Units)		
Dissolving Kraft	3	3	3	3	1086- 2220	935-1326	1475	1160	Biological Treatment
Market Bleached Kraft	6	6	6	6	1420- 1920	1310-1920	1680	1597	Biological Treatment
BCT Bleached Kraft	9	9	9	9	875- 2030	1340-2040	1233	1610	Biological Treatment
Alkaline-Fine	9	9	9	9	630- 1210	430-1380	850	826	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	3	70- 290	190- 240	173	213	Biological Treatment
o Bag	6	6	6	6	340- 1900	350-2400	1130	1208	Biological Treatment
Semi-Chemical	6	6	6	6	1820- 8000	2350-6400	3915	3825	Biological Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples Influent	Total Number of Samples Effluent	Total Number of Detected Analyses Influent	Total Number of Detected Analyses Effluent	Concentration (Platinum Cobalt Units) Influent	Concentration (Platinum Cobalt Units) Effluent	Average Concentration (Platinum Cobalt Units) Influent	Average Concentration (Platinum Cobalt Units) Effluent	Comments
149. Color (continued)									
Unbleached Kraft and Semi-Chemical	6	6	6	6	200- 1080	170- 390	425	258	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	1070- 2600	850-3600	1506	1668	Biological Treatment
Papergrade Sulfite	12	12	12	12	14- 7100	<5-3150	3046	1500	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	<5- 300	<5- 48	139	21	Biological Treatment
Deink									
o Fine Papers	3	3	3	3	48- 140	31- 90	103	68	Biological Treatment
o Newsprint	3	--	3	--	160- 420	-- --	320	--	POTW
o Tissue Papers	3	3	3	3	210- 220	100- 190	217	153	Partial Final Effluent
	3	3	3	3	<5 --	<5 --	<5	<5	Biological Treatment
Tissue From Wastepaper	6	6	6	6	<5- 470	14- 50	88	31	Biological Treatment
	3	3	3	3	5- 40	14- 50	23	38	Primary Treatment
Paperboard From Wastepaper	15	15	15	15	<5- 570	<5- 200	159	86	Biological Treatment
	3	3	3	3	950- 970	880- 920	960	897	Primary Treatment
Wastepaper-Molded Products	3	3	3	3	82- 170	23- 810	121	302	Biological Treatment
	3	--	3	--	<5- 125	-- --	53	--	POTW
Builders' Paper and Roofing Felt	9	--	9	--	370- 1980	-- --	936	--	POTW
	3	3	3	3	7600- 8300	7400-8300	8000	8000	Primary Treatment
Nonintegrated-Fine Papers	6	6	6	6	<5 --	<5 --	<5	<5	Biological Treatment
	3	3	3	3	48- 830	6- 82	311	34	Primary Treatment
Nonintegrated-Tissue Papers	3	3	3	3	<5 --	<5 --	<5	<5	Biological Treatment
	3	3	3	3	<5	<5	<5	<5	Primary Treatment
Nonintegrated-Lightweight Papers	3	3	3	2	<5 --	<5- --	<5	<5	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	<5 --	<5 --	<5	<5	Primary Treatment
	3	3	3	3	10- 100	<5- 20	43	10	Biological Treatment
Nonintegrated-Paperboard	6	6	6	5	<5- 14	0- 50	7	15	Biological Treatment
Integrated Miscellaneous	12	12	12	12	<5- 4660	<5-4590	1060	938	Biological Treatment
Nonintegrated Miscellaneous	6	6	6	6	<5 --	<5 --	<5	<5	Primary Treatment
	3	3	3	3	<5 --	<5 --	<5	<5	Primary w/Holding Pond

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples		Total Number of Detected Analyses		Concentration Range		Average Concentration		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
150. Ammonia					(mg/l)		(mg/l)		
Dissolving Sulfite Pulp	4	4	3	3	6.2- 24.3	3.45- 9.5	12	7	Biological Treatment
Papergrade Sulfite	12	12	2	3	0- 260	6.8- 48	105	21	Biological Treatment
151. COD									
Dissolving Kraft	2	3	2	3	1290- 1510	330- 780	1400	497	Biological Treatment
Market Bleached Kraft	6	6	6	6	530- 920	370- 440	735	407	Biological Treatment
BCT Bleached Kraft	9	9	9	9	300- 1270	290- 470	765	397	Biological Treatment
Alkaline-Fine	9	9	9	9	400- 820	110- 310	576	244	Biological Treatment
Unbleached Kraft									
o Linerboard	3	3	3	3	550- 670	220- 490	617	310	Biological Treatment
o Bag	6	6	6	6	590- 1840	345-1000	1113	663	Biological Treatment
Semi-Chemical	6	6	6	6	1940- 2820	1055-1930	2410	1493	Biological Treatment
Unbleached Kraft and Semi-Chemical	6	6	6	6	648- 1296	80- 464	897	310	Biological Treatment
Dissolving Sulfite Pulp	4	4	4	4	1744- 3170	1040-2170	2251	1404	Biological Treatment
Papergrade Sulfite	12	12	12	12	780- 8700	690-2370	4901	1342	Biological Treatment
Groundwood-Fine Papers	6	6	6	6	450- 1020	77- 200	625	136	Biological Treatment
Deink									
o Fine Papers	3	3	3	3	700- 2850	50- 260	1600	170	Biological Treatment
o Newsprint	3	--	3	--	1980- 4720	-- --	3733	--	POTW
o Tissue Papers	3	3	3	3	1700- 2400	360- 500	2063	430	Partial Final Effluent
	3	3	3	3	370- 512	77- 87	435	82	Biological Treatment
Tissue From Wastepaper	6	5	6	5	230- 500	170- 220	363	192	Biological Treatment
	3	3	3	3	160- 250	110- 156	190	131	Primary Treatment
Paperboard From Wastepaper	14	15	14	15	164- 6400	5- 540	1333	201	Biological Treatment
	3	3	3	3	8440- 9060	2980-8320	8833	4797	Primary Treatment
Wastepaper-Molded Products	3	3	3	3	262- 346	66- 101	291	82	Biological Treatment
	3	--	3	--	560- 880	-- --	693	--	POTW
Builders' Paper and Roofing Felt	8	--	8	--	2560- 5120	-- --	3923	--	POTW
	3	3	3	3	11800-19500	16100-24300	16667	19133	Primary Treatment
Nonintegrated-Fine Papers	6	6	6	6	87- 220	73- 110	168	87	Biological Treatment
	3	3	3	3	254- 763	22- 26	437	25	Primary Treatment
Nonintegrated-Tissue Papers	3	3	3	3	16- 20	85- 110	18	95	Biological Treatment
	3	3	3	3	26- 666	102- 142	399	119	Primary Treatment

TABLE V-32 (Continued)

Toxic Pollutant/ Subcategory	Total Number of Samples Influent	Total Number of Samples Effluent	Total Number of Detected Analyses Influent	Total Number of Detected Analyses Effluent	Concentration Range (mg/1) Influent	Concentration Range (mg/1) Effluent	Average Concentration mg/1) Influe	Average Concentration mg/1) Effluent	Comments
151. COD (continued)									
Nonintegrated-Lightweight Papers	3	3	3	3	230- 475	45- 90	313	69	Biological Treatment
Nonintegrated-Filter and Nonwoven Papers	3	3	3	3	77- 136	13- 57	104	28	Primary Treatment
	3	3	3	3	230- 250	40- 56	240	49	Biological Treatment
Nonintegrated-Paperboard	6	6	6	6	<5- 370	12- 97	203	46	Biological Treatment
Integrated Miscellaneous	12	12	12	12	140- 2240	92- 590	848	255	Biological Treatment
Nonintegrated Miscellaneous	6	6	6	6	125- 230	28- 80	184	48	Primary Treatment
	3	3	3	3	130- 810	81- 98	493	89	Primary w/Holding Pond

TABLE V-33

SUMMARY OF LONG-TERM SAMPLING PROGRAM ANALYSIS RESULTS FOR TOXIC POLLUTANTS

Toxic Pollutant/Subcategory	Total Number of Samples			Total Number of Detected Analyses			Concentration Range(μg/l)			Average Concentration(μg/l)		
	Raw Waste*	Secondary Influent*	Final Effluent**	Raw Waste	Seconday Influent	Final Effluent	Raw Waste	Seconday Influent	Final Effluent	Raw Waste	Seconday Influent	Final Effluent
21. 2,4,6-Trichlorophenol												
Fine Bleached Kraft	0	23	69	--	13	63	--	0-5	0-6	--	1.8	2.7
Deink-Tissue Papers	23	19	69	22	18	59	0-16	0-15	0-22	8.8	8.4	3.7
22. Chloroform												
Fine Bleached Kraft	0	23	69	--	23	69	--	227-772	21-230	--	404	58
Deink-Tissue Papers	23	19	69	23	19	69	19-600	60-800	10-61	273	262	32
31. 2,4-Dichlorophenol												
Fine Bleached Kraft	0	23	69	--	2	4	--	0-1	0-2	--	0.1	0.1
Deink-Tissue Papers	23	19	69	18	4	9	0-6	0-2	0-8	1.8	0.4	0.4
64. Pentachlorophenol												
Fine Bleached Kraft	0	23	69	--	6	15	--	0-11	0-7	--	1.2	0.8
Deink-Tissue Papers	23	19	69	22	16	42	0-13	0-12	0-23	4.8	3.8	2.5
106. PCB-1242												
Deink-Tissue Papers	23	19	69	23	19	69	2.0-77.0	0.6-9.6	0.2-1.9	21.3	3.8	0.8

*72-hour composite samples
**24-hour composite samples

TABLE V-34

SUMMARY OF LONG-TERM SAMPLING PROGRAM ANALYSIS RESULTS FOR NONCONVENTIONAL POLLUTANTS

Toxic Pollutant/Subcategory	Total Number of Samples			Total Number of Detected Analyses			Concentration Range (μg/l)			Average Concentration(μg/l)		
	Raw Waste*	Secondary Influent*	Final Effluent**	Raw Waste	Seconday Influent	Final Effluent	Raw Waste	Seconday Influent	Final Effluent	Raw Waste	Seconday Influent	Final Effluent
130. Abietic Acid												
Fine Bleached Kraft	--	23	69	--	23	59	--	200-12,000	0-8,000	--	1,890	298
Deink-Tissue Papers	3	1	11	3	1	0	55-156	34	0	110	34	0
131. Dehydroabietic Acid												
Fine Bleached Kraft	--	23	69	--	23	55	--	12-1,800	0-1,300	--	259	37
Deink-Tissue Papers	3	1	11	3	1	7	180-405	275	0-16	291	275	5
132. Isopimaric Acid												
Fine Bleached Kraft	--	23	69	--	23	61	--	140-4,900	0-3,900	--	773	354
Drink-Tissue Papers	3	1	11	3	1	1	19-57	81	0-5	36	81	0.5
133. Pimaric Acid												
Fine Bleached Kraft	--	23	69	--	21	25	--	0-530	0-370	--	70	11
Deink-Tissue Papers	3	1	11	2	0	2	0-13	0	0-11	4.3	0	1.4
134. Oleic Acid												
Fine Bleached Kraft	--	23	69	--	19	44	--	0-6,700	0-3,700	--	1,130	119
Deink-Tissue Papers	3	1	11	1	0	1	0-322	0	0-8	107	0	0.7
135. Linoleic Acid												
Fine Bleached Kraft	--	23	69	--	23	55	--	390-12,000	0-3,900	--	2,160	108
Deink-Tissue Papers	3	1	11	3	1	0	120-286	49	0	187	49	0
136. Linolenic Acid												
Fine Bleached Kraft	--	23	69	--	3	2	--	0-480	0-25	--	50	0.6
Deink-Tissue Papers	3	1	11	1	0	1	0-90	0	0-10	30	0	0.9
137. Epoxystearic Acid												
Fine Bleached Kraft	--	10	30	--	10	18	--	85-490	0-63	--	208	9.7
Deink Tissue Papers	3	1	11	3	0	1	11-44	0	0-6	26	0	0.5
138. Dichlorostearic Acid												
Fine Bleached Kraft	--	23	69	--	20	44	--	0-640	0-125	--	175	19
Deink Tissue Papers	3	1	11	1	0	3	0-25	0	0-64	8.3	0	13
139. Monochlorodehydro-abietic Acid												
Fine Bleached Kraft	--	23	69	--	19	25	--	0-217	0-110	--	66	8.1
Deink-Tissue Papers	3	1	11	1	0	0	0-14	0	0	4.7	0	0

*72-hour composite samples
**24-hour composite samples

TABLE V-34 (Continued)

Toxic Pollutant/Subcategory	Total Number of Samples			Total Number of Detected Analyses			Concentration Range(µg/l)			Average Concentration(µg/l)		
	Raw Waste*	Secondary Influent*	Final Effluent**	Raw Waste	Seconday Influent	Final Effluent	Raw Waste	Seconday Influent	Final Effluent	Raw Waste	Seconday Influent	Final Effluent
140. Dichlorodehydro-abietic Acid												
Fine Bleached Kraft	--	23	69	--	13	24	--	0-41	0-33	--	9.6	2.6
Deink-Tissue Papers	3	1	11	0	0	0	0	0	0	0	0	0
141. 3,4,5-Trichloro-guaiacol												
Fine Bleached Kraft	--	23	69	-	5	19	--	0-4	0-7	--	0.6	0.7
Deink-Tissue Papers	3	1	11	0	0	0	0	0	0	0	0	0
142. Tetrachloroguaiacol												
Fine Bleached Kraft	--	23	69	--	[illegible]	13	--	0-2	0-6	--	0.2	0.3
Deink-Tissue Papers	3	1	11	0	0	0	0	0	0	0	0	0
153. Palustric Acid												
Fine Bleached Kraft	--	23	69	--	12	27	--	0-1,800	0-1,100	--	170	25
Deink-Tissue Papers	3	1	11	3	1	0	20-59	17	0	39	17	0
154. Levopimaric Acid												
Fine Bleached Kraft	--	23	69	--	0	2	--	0	0-66	--	0	1.5
Deink-Tissue Papers	3	1	11	1	0	0	0-37	0	0	12	0	0
155. 4,5,6-Trichloroguaicol												
Fine Bleached Kraft	--	23	69	--	0	1	--	0	0-2	--	0	0
Deink-Tissue Papers	3	1	11	0	0	0	0	0	0	0	0	0
156. Neoabietic Acid												
Fine Bleached Kraft	--	23	69	--	16	35	--	0-5,200	0-3,000	--	818	95
Deink-Tissue Papers	3	1	11	0	0	0	0	0	0	0	0	0
157. 4,5-Dichloroguaiacol												
Fine Bleached Kraft	--	23	69	--	2	0	--	0-1	0	--	0	0
Deink-Tissue Papers	3	1	11	0	0	0	0	0	0	0	0	0
158. Sandaracopimaric Acid												
Fine Bleached Kraft	--	23	69	--	19	27	--	0-690	0-570	--	125	17
Deink-Tissue Papers	3	1	11	1	0	0	0-44	0	0	15	0	0
161. 2,4,5-Trichlorophenol												
Fine Bleached Kraft	--	23	69	--	0	0	--	0	0	--	0	0
Deink-Tissue Papers	23	19	69	1	1	5	0-11	0-10	0-8.4	0.5	0.5	0.3
162. Dimethyl Sulfide												
Fine Bleached Kraft	--	23	69	--	23	45	--	448-3,740	0-230	--	1,370	55
Deink-Tissue Papers	3	1	11	0	0	0	0	0	0	0	0	0

*72-hour composite samples
**24-hour composite samples

TABLE V-34 (Continued)

Toxic Pollutant/Subcategory	Total Number of Samples			Total Number of Detected Analysis			Concentration Range(µg/l)			Average Concentration(µg/l)		
	Raw Waste*	Secondary Influent*	Final Effluent**	Raw Waste	Seconday Influent	Final Effluent	Raw Waste	Seconday Influent	Final Effluent	Raw Waste	Seconday Influent	Final Effluent
163. Dimethyl Disulfide												
Fine Bleached Kraft	--	23	69	--	23	5	--	38-1,800	0-13	--	743	0.6
Deink-Tissue Papers	3	1	11	0	0	0	0	0	0	0	0	0

*72-hour composite samples
**24-hour composite samples

samples taken, the number of samples where each pollutant was detected, and the concentration ranges for each pollutant.

Summary

Table V-35 lists the total number of facilities sampled during the screening, verification, and long-term sampling programs by subcategory.

Supplemental Data on Nonconventional Pollutants

Color. Table V-36 presents additional color data obtained during earlier EPA investigations (under Contract No. 68-01-3287). These data were used to supplement color data obtained during verification sampling.

Ammonia. Limited data are available on raw waste or final effluent ammonia discharge levels at the eight mills where ammonia is used as a cooking chemical. Theoretical calculations of the range of ammonia concentrations in raw wastewaters were developed based on typical rates of ammonia loss during pulping and pulp washing (losses due to volatilization have not been considered in these calculations). Table V-37 presents theoretical raw waste loads of ammonia in the subcategories where ammonia is used as the base chemical in pulping (semi-chemical, dissolving sulfite pulp, and both papergrade sulfite subcategories).

Limited data are available on actual ammonia raw waste loads. Table V-38 presents available ammonia data for five of the eight mills where ammonia is used for pulping. These data are generally within the range presented in Table V-37 and tend to support the theoretical calculations.

TABLE V-35

TOXIC POLLUTANT SAMPLING
DATA BASE

Subcategory or Mill Grouping	No. Mills Sampled EPA Region Screening	No. Mills Sampled Screening	Verification	Long-Term Sampling	Total Mill Visits
Dissolving Kraft	1	0	1	0	2
Market Bleached Kraft	4	0	2	0	6
BCT Bleached Kraft	2	1	3	0	6
Alkaline-Fine[1]	5	0	3	1	9
Unbleached Kraft					
o Linerboard	4	1	1	0	6
o Bag	0	0	2	0	2
Semi-Chemical	3	1	2	0	6
Unbleached Kraft and Semi-Chemical	2	1	2	0	5
Dissolving Sulfite Pulp	4	0	2	0	6
Papergrade Sulfite[2]	0	1	4	0	5
Groundwood-Thermo-Mechanical	2	0	0	0	2
Groundwood-CMN Papers	1	0	0	0	1
Groundwood-Fine Papers	0	1	2	0	3
Deink					
o Fine Papers	0	0	1	0	1
o Tissue Papers	0	1	2	1	4
o Newsprint	1	0	1	0	2
Tissue From Wastepaper	0	0	3	0	3
Paperboard From Wastepaper	5	0	6	0	11
Wastepaper-Molded Products	0	0	2	0	2
Builders' Paper and Roofing Felt	2	0	4	0	6
Nonintegrated-Fine Papers	0	1	3	0	4
Nonintegrated-Tissue Papers	0	1	2	0	3
Nonintegrated-Lightweight Papers	0	0	1	0	1
Nonintegrated-Filter and Nonwoven Papers	1	0	2	0	3
Nonintegrated-Paperboard	0	0	2	0	2
Integrated Miscellaneous	7	1	4	0	12
Secondary Fibers-Miscellaneous	1	1	0	0	2
Nonintegrated Miscellaneous	2	0	3	0	5
Total	47	11	60	2	120[3]

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

[3] Some mills sampled for screening and verification; 107 different facilities were sampled.

TABLE V-36

SUPPLEMENTAL COLOR DATA

Subcategory	Total Number of Samples		Concentration Range (Platinum Cobalt Units)		Average Concentration (Platinum Cobalt Units)		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	
Dissolving Kraft	6	6	1310-1780	1170-1710	1545	1460	Biological Treatment
Market Bleached Kraft	12	12	1010-2360	1040-2360	1733	1830	Biological Treatment
BCT Bleached Kraft	12	12	1040-3380	1160-1830	1625	1480	Biological Treatment
Alkaline-Fine[1]	21	23	650-1480	480-1830	953	953	Biological Treatment

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

TABLE V-37

THEORETICAL RAW WASTE AMMONIA LOAD

Subcategory	Ammonia Required(a) (lb/t)	BPT RWL Flow (kgal/t)	Assumed Recovery Efficiency %	Raw Waste Load NH3-N (lb/t)	Raw Waste Load NH3-N (mg/l)
Semi-Chemical	67	10.3	50	33.5	390
		10.3	90	6.7	80
Dissolving Sulfite Pulp	125	66.0	50	62.5	114
		66.0	90	12.5	23
Papergrade Sulfite	100	44.5	50	50.0	135
		44.5	90	10.0	27

(a) Reported average ammonia (as nitrogen) required per ton of pulp produced.(28)

TABLE V-38

SUMMARY OF AVAILABLE AMMONIA DATA FOR ALL MILLS USING AMMONIA AS THE CHEMICAL PULPING BASE

	Raw Waste Averages (NH3-N)					Final Effluent Averages (NH3-N)				
Mill	mg/l	lb/d	lb/t	Months of Data	Data Source	mg/l	lb/d	lb/t	Months of Data	Data Source
Semi-Chemical										
020014	337	10,100	20.2	12	DMR	266	7,990	16.0	12	DMR
Dissolving Sulfite Pulp										
046005	*	*	*	*		*	*	*	*	
046006	20	3,490	6.9	1	Verification	5	788	1.6	1	Verification
Papergrade Sulfite										
040001(a)	*	*	*	*		124	3,130	31.3	14	DMR
040001(a)	*	*	*	*		139	4,860	*	12	(b)
040008	*	*	*	*		*	*	*	*	
040012	50	7,540	27.2	9	Supplemental	43	6,170	21.4	35	DMR, Supplemental
040016	*	*	*	*		*	*	*	*	
040019(c)	157	2,680	4.0	1	Verification	20.9	1,590	2.4	1	Verification
040019	*	*	*	*		19	1,406	1.7	22	DMR, Supplemental
040020	*	*	*	*		*	*	*	*	
Industry Submitted Data										
A	*	*	*	*		9.1	1,790	*	19	Industry Submitted Data
B(d)	*	*	*	*		16.6	993	*	15	Industry Submitted Data
C	*	*	*	*		12.1	1,260	*	9	Industry Submitted Data
E	*	*	*	*		11.4	1,520	*	2	Industry Submitted Data
F	*	*	*	*		5.2	716	*	1	Industry Submitted Data

* Data Not Available

(a) Mill added ammonia to effluent for neutralization; mill is now closed.

(b) Data from "Aerated Lagoon Treatment of Sulfite Pulping Effluents," Report to U.S. Environmental Protection Agency, Water Pollution Control Research Series Program 12040 ELW, December 1970. (39)

(c) Raw waste averages are for the pulp mill only.

(d) Effluent data is based on discharge from biological treatment receiving pulp mill waste only. Concentration reported is that calculated for total mill discharge assuming no ammonia is present in the balance of the mill wastewater.

SECTION VI

SELECTION OF POLLUTANT PARAMETERS

WASTEWATER PARAMETERS OF SIGNIFICANCE

The Agency has conducted an exhaustive study of the pulp, paper, and paperboard industry to establish effluent limitations reflecting the best practicable control technology currently available (BPT) and the best available technology economically achievable (BAT), new source performance standards (NSPS), and pretreatment standards for new and for existing sources (PSNS and PSES). After completion of a review of existing regulations, a review of available literature, and an evaluation of data obtained during sampling at over 100 mills, the following pollutant parameters have been identified as present in pulp, paper, and paperboard wastewaters and should be subject to limitation under BPT and BAT regulations, NSPS, PSNS, and PSES, as appropriate:

Conventional Pollutants:	BOD_5, TSS, and pH.
Toxic Pollutants:	Trichlorophenol (TCP), pentachlorophenol (PCP), and zinc.

SELECTION OF WASTEWATER PARAMETERS OF SIGNIFICANCE

The EPA's determination of pollutant parameters of significance in wastewater discharges from the pulp, paper, and paperboard industry involved a review of existing regulations and an evaluation of data obtained after completion of an extensive sampling program.

All pollutants detected in pulp, paper, and paperboard wastewaters are subject to limitation except if excluded for one or more of the following reasons:

Conventional Pollutants

1. The pollutant is indirectly measured by measurement for another parameter.
2. The pollutant is indirectly controlled when a selected parameter is controlled.
3. Insufficient data are available on which to base limitations.

Toxic Pollutants

Paragraph 8 of the Settlement Agreement in Natural Resources Defense Council, Inc. v. Train, 8 ERC 2120 (D.D.C. 1976), modified, 12 ERC 1833 (D.D.C. 1979)(1)(2), provides guidance to the Agency on exclusions of specific toxic pollutants, subcategories, or categories from regulations under the effluent limitations guidelines, standards of performance, and pretreatment standards:

> "8(a) The Administrator may exclude from regulation under the effluent limitations and guidelines, standards of performance, and/or pretreatment standards contemplated by this Agreement a specific pollutant or category or subcategory of point sources for any of the following reasons, based upon information available to him:
>
> (i) For a specific pollutant or a subcategory or category, equally or more stringent protection is already provided by an effluent, new source performance, or pretreatment standard or by an effluent limitation and guideline promulgated pursuant to Section(s) 301, 304, 306, 307(a), 307(b) or 307(c) of the Act;
>
> (ii) For a specific pollutant, except for pretreatment standards, the specific pollutant is present in the effluent discharge solely as a result of its presence in intake waters taken from the same body of water into which it is discharged and, for pretreatment standards, the specific pollutant is present in the effluent which is introduced into treatment works (as defined in Section 212 of the Act) which are publicly owned solely as a result of its presence in the point source's intake waters, provided however, that such point source may be subject to an appropriate effluent limitation for such pollutant pursuant to the requirements of Section 307;
>
> (iii) For a specific pollutant, the pollutant is not detectable (with the use of analytical methods approved pursuant to 304(h) of the Act, or in instances where approved methods do not exist, with the use of analytical methods which represent state-of-the-art capability) in the direct discharges or in the effluents which are introduced into publicly-owned treatment works from sources within the subcategory or category; or is detectable in the effluent from only a small number of sources within the subcategory and the pollutant is uniquely related to only those sources; or the

pollutant is present only in trace amounts and is neither causing nor likely to cause toxic effects; or is present in amounts too small to be effectively reduced by technologies known to the Administrator; or the pollutant will be effectively controlled by the technologies upon which are based other effluent limitations and guidelines, standards of performance, or pretreatment standards; or

(iv) For a category or subcategory, the amount and the toxicity of each pollutant in the discharge does not justify developing national regulations in accordance with the schedule contained in Paragraph 7(b).

(b) The Administrator may exclude from regulation under the pretreatment standards contemplated by this Agreement all point sources within a point source category or point source subcategory:

(i) if 95 percent or more of all point sources in the point source category or subcategory introduce into treatment works (as defined in Section 212 of the Act) which are publicly owned only pollutants which are susceptible to treatment by such treatment works and which do not interfere with, do not pass through, or are not otherwise incompatible with such treatment works; or

(ii) if the toxicity and amount of the incompatible pollutants (taken together) introduced by such point sources into treatment works (as defined in Section 212 of the Act) that are publicly owned is so insignificant as not to justify developing a pretreatment regulation..."

Nonconventional Pollutants

1. The pollutant is indirectly measured by measurement for another parameter.

2. The pollutant is indirectly controlled when a selected parameter is controlled.

3. Insufficient data are available on which to base limitations.

4. The pollutant is not of uniform national concern (i.e., the pollutant is present at only a small number of sources and is

uniquely related to those sources) and should be regulated on a case-by-case basis, as appropriate.

5. The pollutant is present but cannot be effectively reduced by technologies known to the Administrator.

Review of Previous Regulations

Conventional, toxic, and nonconventional pollutants have been limited under promulgated effluent limitations guidelines and new source performance standards applicable to wastewater discharges from the pulp, paper, and paperboard and builders' paper and board mills point source categories (see 39 FR 16578, 39 FR 18742, and 42 FR 1398). (3)(4)(5) Table VI-1 presents a summary of the pollutants that have been regulated or have been addressed in previous Agency rulemakings for each of the subcategories of the industry.

Conventional Pollutants. Regulations limiting the discharge of BOD_5, TSS, and pH were proposed and/or promulgated for the original 22 subcategories of the pulp, paper, and paperboard industry (see Section IV). These pollutants are subject to regulation as specified in section 306 based on the best available demonstrated technology and in sections 301(b)(2)(E) and 304(a)(4) through identification of the "best conventional pollutant control technology" (BCT). As discussed in Sections II and XI, this document does not address establishment of BCT limitations.

Toxic Pollutants. The only toxic pollutant regulated in the past was zinc (see 42 FR 1398). (5) This pollutant was regulated in the groundwood-thermo-mechanical, groundwood-CMN papers, and groundwood-fine papers subcategories; at the time of promulgation of BPT effluent limitations, zinc was commonly discharged at mills in these subcategories due to the use of zinc hydrosulfite as a bleaching chemical.

Responses obtained during a survey of the industry indicated that zinc hydrosulfite was still used at one mill. Since the potential exists for the discharge of zinc due to the continued use of zinc hydrosulfite, EPA decided to continue to regulate this pollutant in those subcategories where zinc is currently regulated.

Nonconventional Pollutants. Two nonconventional pollutants were controlled under prior regulations: settleable solids and color. Settleable solids were limited under regulations applicable to the builders' paper and roofing felt subcategory of the builders' paper and board mills point source category. (3) Settleable solids are measured during the analysis for suspended solids (TSS), a conventional pollutant. Therefore, EPA concluded that (a) settleable solids will be controlled by NSPS for TSS and by limitations, when established, that reflect the best conventional pollutant control technology (BCT) and (b) that BAT limitations for control of settleable solids are unnecessary and redundant.

TABLE VI-1
SUMMARY OF PARAMETERS PROPOSED OR PROMULGATED FOR EFFLUENT LIMITATIONS GUIDELINES BY SUBCATEGORY

Subcategory	Conventional Pollutants				Toxic Pollutant	Nonconventional Pollutant
	BOD5	TSS	pH	Settleable Solids	Zinc	Color
Integrated Segment						
Dissolving Kraft	X	X	X	-	-	*
Market Bleached Kraft	X	X	X	-	-	*
BCT Bleached Kraft	X	X	X	-	-	*
Alkaline-Fine[1]	X	X	X	-	-	*
Unbleached Kraft	X	X	X	-	-	X
Semi-Chemical	X	X	X	-	-	X
Unbleached Kraft and Semi-Chemical	X	X	X	-	-	X
Dissolving Sulfite Pulp[2]	X	X	X	-	-	-
Papergrade Sulfite[3]	X	X	X	-	-	-
Groundwood-Chemi-Mechanical	X	X	X	-	X	-
Groundwood-Thermo-Mechanical	X	X	X	-	X	-
Groundwood-CMN Papers	X	X	X	-	X	-
Groundwood-Fine Papers	X	X	X	-	X	-
Secondary Fibers Segment						
Deink	X	X	X	-	-	-
Tissue From Wastepaper	X	X	X	-	-	-
Paperboard From Wastepaper	X	X	X	-	-	-
Wastepaper-Molded Products[4]	-	-	-	-	-	-
Builders' Paper and Roofing Felt	X	X	X	X	-	-
Nonintegrated Segment						
Nonintegrated-Fine Papers	X	X	X	-	-	-
Nonintegrated-Tissue Papers	X	X	X	-	-	-
Nonintegrated-Lightweight Papers[4]	-	-	-	-	-	-
Nonintegrated-Filter and Nonwoven Papers[4]	-	-	-	-	-	-
Nonintegrated-Paperboard[4]	-	-	-	-	-	-

X Regulations were proposed and promulgated for this pollutant or pollutant parameter.
* Regulations were proposed for this pollutant or pollutant parameter.

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] The BPT BOD5 effluent limitation for acetate grade production in the Dissolving Sulfite Pulp subcategory was remanded to EPA.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

[4] These are new subcategories for which the Agency is establishing effluent limitations and standards for the first time.

BAT limitations were established for control of color in discharges from mills in the unbleached kraft, sodium-based neutral sulfite semi-chemical (NSSC), ammonia-based neutral sulfite semi-chemical (NSSC), and unbleached kraft/NSSC (cross recovery) subcategories (see 39 FR 18742). (4) EPA proposed BAT color limits for the dissolving kraft, market bleached kraft, BCT (paperboard, coarse, and tissue) bleached kraft, fine bleached kraft, and soda subcategories. However, as discussed in Section II, BAT limitations were never promulgated for these subcategories. Additional subcategories where highly-colored effluents are discharged include both papergrade sulfite subcategories and the dissolving sulfite pulp subcategory.

As a result of further investigations by the Agency since the prior BAT limitations were proposed and promulgated, EPA concluded that the discharge of color in pulp, paper, and paperboard effluents is not of uniform national concern. Therefore, EPA proposed to withdraw all color limitations and will control color on a case-by-case basis as dictated by water quality considerations. While uniform national color limitations will not be established, the capabilities and costs of various end-of-pipe treatment techniques for the removal of color are presented in Sections VII, VIII, and Appendix A of this document as a reference for use by permit writers.

Identification Of Other Compounds Of Concern

In addition to the pollutants controlled by existing regulations, EPA investigated the potential for discharge of other toxic and nonconventional pollutants from the pulp, paper, and paperboard industry. A total of 129 specific toxic pollutants and 14 additional nonconventional pollutants were the subject of extensive study (see Section II). EPA conducted screening and verification studies that led to the exclusion of many specific toxic pollutants from regulation based on the guidance provided in Paragraph 8 of the Settlement Agreement.

Screening Program. As discussed in Section II, the screening program consisted of three separate investigations: a) the initial contractor screening program, b) contractor screening studies conducted during verification sampling, and c) screening studies conducted by Regional Surveillance and Analysis (S&A) field teams.

Results of Initial Contractor Screening Program-Table II-3 presents the list of toxic and additional nonconventional pollutants analyzed as part of the screening program. Table V-28 presents a summary of the results of the contractor's initial screening studies. As previously discussed in Section II, EPA determined the specific toxic pollutants to be investigated during the verification program based on this abbreviated initial screening program and on other available data including information obtained in literature reviews and during the industry survey program. Specific pollutants were eliminated from investigation during the verification program only if the pollutant was not detected in wastewater samples collected during the initial contractor screening program, with the exception of seven metals: antimony, arsenic, beryllium, cadmium, selenium, silver, and thallium. Based on initial screening results, EPA determined that these seven metals were present in amounts too small to be effectively reduced by the application of available control and treatment technologies.

Results of Contractor Screening Studies Conducted During Verification Sampling-Table V-29 presents the results of screening studies conducted by the contractor during verification sampling at 17 mills where processes were employed that are representative of those segments of the pulp, paper, and paperboard industry not included in the contractor's initial screening investigations.

Results of Regional S&A Screening Studies-Table V-30 presents the results of screening studies conducted by EPA Regional S&A field teams.

Exclusion of Toxic Pollutants From Regulation Based on the Results of the Screening Program-Table VI-2 presents a list of those specific toxic pollutants that EPA excluded from regulation based on screening program results and the reasons for those exclusions.

Verification Program. Table II-8 presents a list of all compounds for which EPA obtained chemical analyses during the verification program. A summary of the analysis results is presented in Table V-31.

Toxic Pollutant Assessment. EPA assessed the analytical results of those toxic pollutants detected in verification program samples to identify those pollutants of potential concern and to determine which pollutants should be subject to limitation through the implementation of uniform national standards.

Anticipated treatability levels for the specific toxic pollutants were developed by personnel in the Office of Quality Review, Effluent Guidelines Division.(40) Projected treatability for metals (zinc, nickel, copper, lead, and chromium) and cyanide were based on the proposed pretreatment regulations for the electroplating industry point source category.(41) The basis for comparing the results for mercury was proposed pretreatment standards for the metal finishing industry. (42) Table VI-3 presents projected treatability levels for those compounds included in the Agency's verification program. EPA compared verification analysis results with the treatabilities listed on Table VI-3 to determine if additional removal of these compounds might be possible through the application of various control and treatment technologies known to be capable of removing specific toxic compounds.

Based on this comparison, EPA eliminated 19 toxic pollutants from further consideration in the assessment of pollutants of potential concern in discharges from the pulp, paper, and paperboard industry. These toxic pollutants were eliminated in accordance with Paragraph 8(a)(iii); EPA determined that these pollutants are "present in

TABLE VI-2
CRITERIA FOR ELIMINATION OF TOXIC POLLUTANTS BASED ON SCREENING PROGRAM RESULTS AND TOXIC POLLUTANTS ELIMINATED

Paragraph 8 (a) (iii) "For a specific pollutant, the pollutant is not detectable....."

1. acenaphthene
2. acrolein
8. 1,2,4-trichlorobenzene
9. hexachlorobenzene
12. hexachloroethane
16. chloroethane
19. 2-chloroethylvinyl ether (mixed)
26. 1,3-dichlorobenzene
28. 3,3'-dichlorobenzidine
32. 1,2-dichloropropane
37. 1,2-diphenylhydrazine
40. 4-chlorophenylphenyl ether
41. 4-bromophenylphenyl ether
46. methyl bromide (bromomethane)
50. dichlorodifluoromethane
52. hexachlorobutadiene
57. 2-nitrophenol
61. N-nitrosodimethylamine
63. N-nitrosodi-n-propylamine
72. benzo[a]anthracene (1,2-benzanthracene)
73. benzo[a]pyrene (3,4-benzopyrene)
74. 3,4-benzofluoranthene
75. benzo[k]fluoranthene (11,12-benzo fluoranthene)
79. benzo[ghi]perylene (1,12-benzoperylene)
80. fluorene
83. indeno[1,2,3-cd]pyrene
88. vinyl chloride (chloroethylene)
89. aldrin
90. dieldrin
91. chlordane (technical mixture and metabolites)
92. 4,4'-DDT
93. 4,4'-DDE (p,p'-DDX)
94. 4,4'-DDD (p,p'-TDE)
95. α-endosulfan
96. β-endosulfan
97. endosulfan sulfate
98. endrin
99. endrin aldehyde
100. heptachlor
101. heptachlor epoxide
102. α-BHC
103. β-BHC
104. γ-BHC (lindane)
105. δ-BHC
113. toxaphene
116. asbestos (fibrous)
129. 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)

TABLE VI-2 (Continued)

Paragraph 8 (a) (iii)

"For a specific pollutant.....is present in amounts too small to be effectively reduced by technologies known to the Administrator....."

3. acrylonitrile
5. benzidine
14. 1,1,2-trichloroethane
17. bis(chloromethyl)ether
20. 2-chloronaphthalene
25. 1,2-dichlorobenzene
27. 1,4-dichlorobenzene
30. 1,2-dichloroethylene
33. 1,3-dichloropropylene
(1,3-dichloropropene)
34. 2,4-dimethylphenol
35. 2,4-dinitrotoluene
36. 2,6-dinitrotoluene
42. bis(2-chloroisopropyl) ether
43. bis(2-chloroethoxv) methane
45. methyl chloride (chloromethane)
53. hexachlorocyclopentadiene
56. nitrobenzene
58. 4-nitrophenol
60. 4,6-dinitro-o-cresol
62. N-nitrosodiphenylamine
71. dimethyl phthalate
114. antimony
115. arsenic
117. beryllium
118. cadmium
125. selenium
126. silver
127. thallium

Paragraph 8 (a) (iii)

"For a specific pollutant.....is detectable in the effluent from only a small number of sources..... and the pollutant is uniquely related to only those sources....."

18. bis (2-chloroethyl) ether
29. 1,1-dichloroethylene
82. dibenzo[a,h]anthracene
(1,2,5,6-dibenzanthracene)

TABLE VI-3

PROJECTED TREATABILITY FOR VERIFICATION PROGRAM TOXIC POLLUTANTS

Verification Compound Toxic Compounds (Priority Pollutants)		Comparison Level (μg/l)	Source for Concentration Used
4.	benzene	50	*
6.	carbon tetrachloride	50	*
7.	chlorobenzene	50	*
10.	1,2-dichloroethane	100	*
11.	1,1,1-trichloroethane	100	*
13.	1,1-dichloroethane	100	*
15.	1,1,2,2-tetrachloroethane	50	*
21.	2,4,6-trichlorophenol	25	*
22.	parachlorometa cresol	50	*
23.	chloroform	100	*
24.	2-chlorophenol	50	*
31.	2,4-dichlorophenol	50	*
38.	ethylbenzene	50	*
39.	fluoranthene	10	*
44.	methylene chloride	100	*
47.	bromoform	50	*
48.	dichlorobromomethane	100	*
49.	trichlorofluoromethane	100	*
50.	dichlorodifluoromethane	100	*
51.	chlorodibromomethane	100	*
54.	isophorone	50	*
55.	naphthalene	50	*
59.	2,4-dinitrophenol	25	*
64.	pentachlorophenol	10	*
65.	phenol	50	*
66.	bis(2-ethylhexyl) phthalate	10	*
67.	butyl benzyl phthalate	1 - 10	*
68.	di-n-butyl phthalate	25	*
69.	di-n-octyl phthalate	10	*
70.	diethyl phthalate	25	*
76.	chrysene	1	*
77.	acenaphthylene	10	*
78.	anthracene	10	*
81.	phenanthrene	10	*
84.	pyrene	1	*
85.	tetrachloroethylene	50	*
86.	toluene	50	*
87.	trichloroethylene	100	*
106.	PCB 1242 (Arochlor 1242)	1	*
107.	PCB 1254 (Arochlor 1254)	1	*
108.	PCB 1221 (Arochlor 1221)	1	*

TABLE VI-3 (continued)

Verification Compound Toxic Compounds (Priority Pollutants)	Comparison Level (μg/l)	Source for Concentration Used
109. PCB 1232 (Arochlor 1232)	1	*
110. PCB 1248 (Arochlor 1248)	1	*
111. PCB 1260 (Arochlor 1260)	1	*
112. PCB 1016 (Arochlor 1016)	1	*
119. chromium	2500	**
120. copper	1800	**
121. cyanide	230	**
122. lead	300	**
123. mercury	100	***
124. nickel	1800	**
128. zinc	1800	**

References

*Murray P. Strier, "Treatability of Organic Priority Pollutants - Part C - Their Estimated (30 Day Average) Treated Effluent Concentration - A Molecular Engineering Approach," Table I, 1978. (40)

** Development Document for Existing Source Pretreatment Standards for the Electroplating Point Source Category, EPA 440/1-79-003, August 1979. (41)

*** Development Document for Proposed Effluent Limitations Guidelines and Standards for the Metal Finishing Point Source Category, EPA 440/1-82/091b, August 1982. (42)

amounts too small to be effectively reduced by technologies known to the Administrator." These toxic pollutants are listed in Table VI-4.

The following compounds were not detected in samples collected at any of 60 mills where verification surveys were conducted:

1,1,2,2-tetrachloroethane
2,4-dinitrophenol
Chrysene
Phenanthrene
Parachlorometa cresol

EPA included chrysene and 1,1,2,2-tetrachloroethane in the verification program because they were detected during the screening program in the raw wastewater from one mill at a level of less than one microgram per liter. These compounds were not detected in either raw wastewater or final effluent samples from any of 60 mills during verification sampling and analysis, including four mills in the same industrial subcategory as the one mill where they were detected during the initial screening program. During screening studies conducted by Regional S&A field teams, 1,1,2,2-tetrachloroethane was detected in the final effluent of one mill at a level lower than the projected treatability level presented in Table VI-3.

EPA included 2,4-dinitrophenol on the list of verification compounds because its use was reported at one mill for which a survey response was received. However, it was not detected in samples collected at any of the 60 mills where verification surveys were conducted. During screening studies conducted by Regional S&A field teams, 2,4-dinitrophenol was detected in the final effluent of one mill at a level lower than the projected treatability level presented in Table VI-3.

Phenanthrene was included in the verification program because the analysis procedures utilized during the screening program did not provide a basis for distinguishing between anthracene and phenanthrene because they co-elute. During screening, the presence of either anthracene or phenanthrene or both was indicated. Therefore, EPA included both anthracene and phenanthrene on the list of compounds to be investigated during verification sampling. The procedures utilized during the verification program allowed for distinction between phenanthrene and anthracene. Phenanthrene was not detected at any of the 60 verification mills.

EPA added parachlorometa cresol to the list of verification compounds because it is a chlorinated phenolic. Based on literature reviews, EPA determined that potential existed for the presence of chlorinated phenolics in pulp, paper, and paperboard effluents. However, parachlorometa cresol was not detected in wastewater samples at any of the 60 verification mills.

The toxic pollutants bis(2-ethylhexyl) phthalate and methylene chloride were eliminated from further consideration because they were

TABLE VI-4

TOXIC POLLUTANTS ELIMINATED FROM ASSESSMENT BASED ON VERIFICATION PROGRAM RESULTS DETECTED BELOW TREATABILITY LEVEL

6. carbon tetrachloride (tetrachloromethane)
7. chlorobenzene
10. 1,2-dichloroethane
13. 1,1-dichloroethane
15. 1,1,2,2-tetrachloroethane[1]
22. parachlorometa cresol[2]
39. fluoranthene
44. methylene chloride[3] (dichloromethane)
48. dichlorobromomethane
49. trichlorofluoromethane
51. chlorodibromomethane
54. isophorone
59. 2,4-dinitrophenol[1]
66. bis(2-ethylhexyl) phthalate[3]
69. di-n-octyl phthalate
76. chrysene[4]
77. acenaphthylene
78. anthracene
81. phenanthrene[5]
108. PCB-1221 (Arochlor 1221)
109. PCB-1232 (Arochlor 1232)
112. PCB-1016 (Arochlor 1016)
119. chromium (total)
120. copper (total)
123. mercury (total)
124. nickel (total)

---

[1] Not detected during verification sampling; detected in final effluent(s) during screening program below treatability level.

[2] Not detected in raw waste or final effluent samples during screening or verification programs.

[3] Laboratory contaminant.

[4] Not detected during verification sampling; detected in raw waste stream(s) below treatability levels during screening program.

[5] Not detected during verification sampling; co-elutes with anthracene using screening procedures.

reported to be laboratory contaminants. Therefore, verification data on these compounds may not be valid. The toxic pollutant methylene chloride is used in the preparation of sample containers and in extraction procedures used in the analysis of semi-volatile organic toxic and nonconventional pollutants.

Based on the comparison of available verification data to the treatability levels developed by the Office of Quality Review, EPA identified for each subcategory those toxic pollutants with concentrations equal to or in excess of specified treatability levels in either the raw wastewater or treated effluent. Table VI-5 presents a summary of the toxic pollutants of potential concern for each subcategory based on this comparison.

Upon determining the toxic pollutants of potential concern, EPA evaluated all available data. The purpose of this analysis was to determine those pollutants of potential concern that should be limited through implementation of uniform national standards. Table VI-6 presents data summaries used in the determination of which toxic pollutants occur at sufficient levels and frequency to require implementation of uniform national standards. The summary includes the range and average concentrations of the toxic pollutants found in raw wastewater and final effluent samples collected at all mills where levels exceeded the treatability levels presented in Table VI-3. Average concentrations were calculated based on those mills in a subcategory where the specific pollutant levels exceeded the treatability level. This method allows presentation of levels of pollutants that would approximate the average concentrations expected at mills where the pollutant is present due to use of similar processes or process chemicals.

As a result of this evaluation, EPA eliminated 20 toxic pollutants from further consideration in the assessment of the necessity for development of uniform national guidelines. Paragraph 8 of the Settlement Agreement provides guidance for the elimination of these specific toxic pollutants. Table VI-7 lists those criteria cited in Paragraph 8 and the specific toxic pollutant(s) eliminated based upon the criteria.

Based on this analysis, the Agency proposed uniform national standards for the control of three additional specific toxic pollutants besides zinc: chloroform, trichlorophenol and pentachlorophenol (see 46 FR 1430; January 6, 1981).

Subsequent to proposal, EPA reviewed its analysis of toxic pollutant discharges from the pulp, paper, and paperboard industry. EPA determined that uniform national standards for the control of trichlorophenol and pentachlorophenol should be promulgated. Trichlorophenol (TCP) and pentachlorophenol (PCP) were consistently detected in treated effluents in excess of treatability levels at those mills where slimicide and biocide formulations containing these compounds were used. Additionally, PCP and TCP are likely to pass through publicly owned treatment works (POTWs). Technology (chemical

TABLE VI-5
SUMMARY OF TOXIC POLLUTANTS OF CONCERN BY SUBCATEGORY

	Toxic Pollutants*																								
Subcategory	4	11	21	23	24	31	38	47	55	64	65	67	68	70	84	85	86	87	106	107	110	111	121	122	128
Integrated Segment																									
Dissolving Kraft	-	-	-	X	-	-	-	-	-	-	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Market Bleached Kraft	-	-	X	X	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BCT Bleached Kraft	-	-	-	X	-	-	-	-	-	X	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Alkaline-Fine[1]	-	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-
Unbleached Kraft																									
o Linerboard	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
o Bag	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Semi-Chemical	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unbleached Kraft and Semi-Chemical	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	X	-	-	-	-	-
Dissolving Sulfite Pulp	-	-	-	X	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Papergrade Sulfite[2]	X	X	X	X	X	X	-	-	X	X	X	-	-	-	-	X	X	-	-	-	-	-	-	-	-
Groundwood-CMN Papers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Groundwood-Fine Papers	-	-	-	X	-	-	-	-	-	X	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-
Secondary Fibers Segment																									
Deink																									
o Fine Papers	-	-	-	X	-	-	-	-	X	X	-	-	-	-	-	X	X	X	X	-	-	-	-	X	-
o Newsprint	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X	-	-
o Tissue Papers	-	-	X	X	-	-	-	-	X	X	X	-	-	-	-	-	-	-	-	X	-	X	-	-	-
Tissue From Wastewater	-	-	-	-	-	-	X	-	-	-	X	-	-	X	-	X	-	-	-	-	-	-	-	-	X
Paperboard From Wastepaper	-	-	X	-	-	-	-	X	-	X	X	X	X	X	-	-	-	-	-	-	X	-	-	X	X
Wastepaper-Molded Products	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Builders' Paper and Roofing Felt	-	-	-	-	-	-	-	-	-	X	X	X	-	X	-	-	X	-	-	-	X	-	X	X	X
Nonintegrated Segment																									
Nonintegrated-Fine Papers	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nonintegrated-Tissue Papers	-	-	-	-	-	-	X	-	-	-	-	X	-	X	-	-	X	-	-	-	-	-	-	-	X
Nonintegrated-Lightweight Papers	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nonintegrated-Filter and Nonwoven Papers	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	X	-	-	-	-	-
Nonintegrated-Paperboard	-	-	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	X	X	X

*Toxic Pollutants are as follows:

4. Benzene
11. 1,1,1-Trichloroethane
21. Trichlorophenol
23. Chloroform
24. 2-Chlorophenol

31. 2,4-Dichlorophenol
38. Ethylbenzene
47. Bromoform
55. Naphthalene
64. Pentachlorophenol

65. Phenol
67. Butyl Benzyl Phthalate
68. Di-n-Butyl Phthalate
70. Diethyl Phthalate
84. Pyrene

85. Tetrachloroethylene
86. Toluene
87. Trichloroethylene
106. PCB 1242
107. PCB 1254

110. PCB 1248
111. PCB 1260
121. Cyanide
122. Lead
128. Zinc

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE VI-6

SUMMARY OF DATA ASSESSMENT - TOXIC POLLUTANTS OF CONCERN

Toxic Pollutant/Subcategory	Number of Samples Analyzed		Number of Samples in Excess of Treatability Levels		Concentration Range μg/l		Average Concentrations μg/l		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
4. Benzene									
Papergrade Sulfite	12	12	3	1	140-150	7-96	147	40	Detected in final effluent samples of one mill at low levels.
11. 1,1,1-Trichloroethane									
Papergrade Sulfite	12	12	3	0	130-2,000	6-8	1,243	7	(a)
Integrated Miscellaneous	12	12	1	0	3-187	0	67	0	
21. 2,4,6-Trichlorophenol									
Market Bleached Kraft	6	6	1	0	13-26	5-6	20	5	
Papergrade Sulfite	12	12	3	3	330-370	170-270	350	210	
Deink									
o Tissue Papers	6	6	3	3	29-65	39-43	48	41	
Paperboard From Wastepaper	18	18	3	3	270-420	420-450	360	430	
Nonintegrated Miscellaneous	9	9	1	1	6-30	6-28	18	19	
23. Chloroform									
Dissolving Kraft	3	3	3	0	360-900	40-86	647	67	
Market Bleached Kraft	6	6	6	0	830-2,200	6-20	1,405	12	
BCT Bleached Kraft	9	9	9	0	580-4,000	0-11	1,550	6	
Alkaline-Fine	9	9	8	3	43-1,800	2-110	1,148	52	
Dissolving Sulfite Pulp	4	4	4	0	110-360	1-42	268	13	
Papergrade Sulfite	12	12	11	12	62-8,600	120-1,200	2,677	433	
Groundwood-Fine Papers	6	6	3	0	130-240	16-36	170	26	
Deink									
o Fine Papers	3	3	3	2	670-9,700	95-240	4,190	145	
o Tissue Papers	6	6	3	0	1,000-1,800	48-61	1,367	55	
Integrated Miscellaneous	12	12	3	0	450-1,100	2-14	833	10	
24. 2-Chlorophenol									
Papergrade Sulfite	12	12	2	0	0-120	21-50	65	37	(a)
31. 2,4-Dichlorophenol									
Papergrade Sulfite	12	12	3	3	180-220	90-130	203	106	(b)
38. Ethylbenzene									
Market Bleached Kraft	6	6	1	0	0-82	0	27	0	Detected in two final effluent samples at one mill where biological treatment is not employed.
Tissue From Wastepaper	9	9	1	0	2-74	0	27	0	
Nonintegrated-Tissue Papers	6	6	3	2	54-39,000	36-300	13,081	149	

(a) Detected in final effluent samples at levels lower than the 30-day average treatability comparison value.

(b) Detected in final effluent samples at levels higher than the 30-day average treatability comparison value only at mill(s) where BPT effluent limitations are not attained.

TABLE VI-6 (Continued)

Toxic Pollutant/Subcategory	Number of Samples Analyzed		Number of Samples in Excess of Treatability Levels		Concentration Range µg/l		Average Concentrations µg/l		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
47. Bromoform									(b)
Paperboard From Wastepaper	18	18	1	1	0-119	0-62	40	21	
55. Naphthalene									(b)
Papergrade Sulfite	12	12	2	1	22-230	7-88	102	36	
Deink									
o Fine Papers	3	3	3	0	67-190	0	142	0	
o Tissue Papers	6	6	2	0	0-78	0	48	0	
64. Pentachlorophenol									
BCT Bleached Kraft	9	9	2	3	5-31	16-21	19	19	
Alkaline-Fine	9	9	1	0	6-11	0-1	8	1	
Papergrade Sulfite	12	12	2	0	9-12	0	11	0	
Groundwood-Fine Papers	6	6	1	0	3-12	0-2	6	1	
Deink									
o Fine Papers	3	3	2	2	9-24	4-20	15	12	
o Tissue Papers	6	6	2	3	10-61	27-38	38	34	
Paperboard From Wastepaper	18	18	5	3	0-1,200	0-1,400	356	400	
Builders' Paper and Roofing Felt	12*	0	6	-	17-160	-	65	-	*1 mill was self-contained and 3 discharge to POTWs.
Integrated Miscellaneous	12	12	3	0	12-29	0-5	23	3	
Nonintegrated Miscellaneous	9	9	2	2	0-200	0-68	72	27	
65. Phenol									(b)
Dissolving Kraft	3	3	1	0	8-110	10-29	54	18	
BCT Bleached Kraft	9	9	5	0	44-92	0-17	67	7	
Unbleached Kraft									
o Linerboard	3	3	2	0	41-110	3-4	77	3	
o Bag	6	6	5	0	50-140	0	89	0	
Semi-Chemical	6	6	6	0	160-400	3-24	230	14	
Unbleached Kraft and Semi-Chemical	6	6	3	0	30-100	0	56	0	
Papergrade Sulfite	12	12	6	2	78-640	0-250	333	80	
Groundwood-Fine Papers	6	6	1	0	15-51	0-5	34	2	
Deink									
o Tissue Papers	6	6	3	0	76-150	0	119	0	
Tissue From Wastepaper	9	9	2	0	24-140	0-6	77	2	
Paperboard From Wastepaper	18	18	9	3	59-500	0-520	204	144	
Builders' Paper and Roofing Felt	12	0	12	0	51-1400	-	409	-	
Nonintegrated-Fine Papers	9	9	2	1	44-150	22-66	94	38	
Nonintegrated-Filter and Nonwoven Papers	6	6	1	0	8-150	0-3	64	1	
Integrated Miscellaneous	12	12	1	0	10-68	0	31	0	

(a) Detected in final effluent samples at levels lower than the 30-day average treatability comparison value.

(b) Detected in final effluent samples at levels higher than the 30-day average treatability comparison value only at mill(s) where BPT effluent limitations are not attained.

TABLE VI-6 (Continued)

Toxic Pollutant/Subcategory	Number of Samples Analyzed		Number of Samples in Excess of Treatability Levels		Concentration Range µg/l		Average Concentrations µg/l		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
67. Butyl Benzyl Phthalate									
Unbleached Kraft									
o Bag	6	6	2	0	0-39	0	23	0	Detected in final effluent samples at very low levels.
Dissolving Sulfite Pulp	4	4	0	1	0	2	0	2	
Deink	.								
o Newsprint	3	0	3	-	3-8	-	5	-	
Paperboard From Wastepaper	18	18	7	3	0-190	0-81	61	21	
Builders' Paper and Roofing Felt	12	0	3	0	5-12	0	9	0	
Nonintegrated-Tissue Papers	6	6	3	1	620-950	0-15	797	5	
68. Di-N-Butyl Phthalate									
BCT Bleached Kraft	9	9	1	0	0-27	0-23	16	8	Detected in fianl effluent samples at very low levels.
Paperboard From Wastepaper	18	18	1	3	0-85	30-55	32	44	
Nonintegrated-Paperboard	6	6	3	1	110-230	0-61	180	20	
70. Diethyl Phthalate									
Tissue From Wastepaper	9	9	1	0	0-55	0	26	0	Detected at low levels in final effluent samples of only two mills where BPT limits are attained.
Paperboard From Wastepaper	18	18	7	5	12-690	0-320	183	138	
Builders' Paper and Roofing Felt	12	0	3	-	0-180	-	42	-	
Nonintegrated-Tissue Papers	6	6	1	0	0-35	0	12	0	
Nonintegrated-Paperboard	6	6	0	2	0-12	0-130	4	58	
84. Pyrene									
Dissolving Kraft	3	3	1	0	0-6	0	2	0	(a)
85. Tetrachloroethylene									
Deink									
o Fine Papers	3	3	2	0	22-180	0	95	0	Only detected in one final effluent sample.
Tissue from Wastepaper	9	9	1	1	0-220	0-57	74	19	
86. Toluene									
Alkaline-Fine	9	9	1	0	1-180	0	62	0	(b)
Papergrade Sulfite	12	12	2	1	10-70	3-66	44	29	
Groundwood-Fine Papers	6	6	1	0	1-63	0	23	0	
Deink									
o Fine Papers	3	3	1	0	11-150	0	58	0	
Builders' Paper and Roofing Felt	12	0	2	-	0-620	-	120	-	
Nonintegrated-Tissue Papers	6	6	1	0	2-380	1-15	130	6	
Integrated Miscellaneous	12	12	3	6	0-660	70-150	147	99	

(a) Detected in final effluent samples at levels lower than the 30-day average treatability comparison value.

(b) Detected in final effluent samples at levels higher than the 30-day average treatability comparison value only at mill(s) where BPT effluent limitations are not attained.

TABLE VI-6 (Continued)

Toxic Pollutant/Subcategory	Number of Samples Analyzed		Number of Samples in Excess of Treatability Levels		Concentration Range µg/l		Average Concentrations µg/l		Comments
	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	
87. Trichloroethylene									(a)
Deink									
o Fine Papers	3	3	3	0	130-850	3-11	493	7	
106. PCB-1242									(a)
Deink									
o Fine Papers	3	3	1	0	0-9.9	0	3	0	
107. PCB-1254									Only detected in one final effluent sample at very low levels.
Unbleached Kraft and Semi-Chemical	6	6	0	1	0	0-2	0	1	
Deink									
o Tissue Papers	6	6	1	0	0-3.8	0	1	0	
Nonintegrated-Filter and Nonwoven Papers	6	6	1	0	0-28	0	9	0	
Nonintegrated Miscellaneous	9	9	1	0	0-7.1	0	2	0	
110. PCB-1248									(a)
Paperboard From Wastepaper	18	18	3	0	8.3-10	0	9	0	
Builders' Paper and Roofing Felt	12	0	2	-	0-7.4	-	4	-	
111. PCB 1260									(a)
Deink									
o Tissue Papers	6	6	3	0	0-3	0	1	0	
121. Cyanide									(a)
Deink									
o Newsprint	3	0	3	-	720-2,600	-	1,560	-	
Builders' Paper and Roofing Felt	12	0	4	-	155-1,200	-	499	-	
Nonintegrated-Paperboard	6	6	1	0	21-1650	16-80	610	42	
122. Lead									(a)
Deink									
o Fine Papers	3	3	1	0	64-320	24-30	149	28	
Paperboard From Wastepaper	18	18	1	0	130-900	<2-140	443	51	
Builders' Paper and Roofing Felt	12	0	2	0	180-880	50-190	355	137	
Nonintegrated-Paperboard	6	6	3	0	3,300-9,000	6-20	6,667	11	
128. Zinc									(b)
Tissue From Wastepaper	9	9	1	0	118-3,560	110-183	1,316	148	
Paperboard From Wastepaper	18	18	5	1	550-4,720	75-1,900	1,811	469	
Builders' Paper and Roofing Felt	12	0	5	-	1,200-3,000	-	2,267	-	
Nonintegrated-Tissue Papers	6	6	3	0	52,000-54,000	60-140	53,333	88	
Nonintegrated-Paperboard	6	6	1	0	170-2,050	54-210	1,273	138	
Nonintegrated Miscellaneous	9	9	1	0	42-3,840	<2-1,000	1,347	401	

(a) Detected in final effluent samples at levels lower than the 30-day average treatability comparison value.

(b) Detected in final effluent samples at levels higher than the 30-day average treatability comparison value only at mill(s) where BPT effluent limitations are not attained.

TABLE VI-7

CRITERIA FOR ELIMINATION OF TOXIC POLLUTANTS BASED ON VERIFICATION PROGRAM RESULTS AND TOXIC POLLUTANTS ELIMINATED

Paragraph 8(a) (iii) "For a specific pollutant . . . . is present in amounts too small to be effectively reduced by technologies known to the Administrator . . ."

4. benzene
11. 1,1,1-trichloroethane
24. 2-chlorophenol
31. 2,4-dichlorophenol
47. bromoform
55. naphthalene
65. phenol
67. butyl benzyl phthalate
68. di-n-butyl phthalate
70. diethyl phthalate
84. pyrene
86. toluene
87. trichloroethylene
121. cyanide
122. lead

Paragraph 8 (a) (iii) "For a specific pollutant..... is detectable in the effluent from only a small number of sources..... and the pollutant is uniquely related to only those sources..."

38. ethylbenzene
85. tetrachloroethylene
107. PCB 1254
110. PCB 1248
111. PCB 1260

substitution) is available that will virtually eliminate the discharge of PCP and TCP associated with the use of chlorophenolic-containing biocides in the pulp, paper, and paperboard industry. The Agency has determined that removal of PCP at POTWs is on the order of only 54 percent. (43) Limited data are available on the TCP removal capability of POTWs; however, available data on the capability of biological treatment to remove TCP indicates that reductions approaching 100 percent do not occur (see Table V-31).

After reviewing all available information, EPA decided to withdraw the chloroform regulations that were proposed for the nine subcategories where chlorine or chlorine-containing compounds are used to bleach pulp. The technology basis of the proposed limitations was biological treatment capable of attaining BPT effluent limitations. Proposed limits were based on the highest concentrations found after biological treatment at mills in the nine subcategories where BPT limitations are being achieved. EPA's review of all available chloroform data, including data provided in comments on the proposed rules, identified nine mills where closed biological systems (either oxygen-activated sludge or deep tank aeration systems) are employed that inhibit chloroform volatilization. The Agency also determined that the nine mills with closed systems are likely to exceed the proposed chloroform limit even when BPT effluent limitations are attained. The Agency decided to withdraw the proposed BAT limitations for chloroform since (a) installation of biological treatment assures adequate treatment of chloroform for all but nine mills and (b) the proposed BAT chloroform limitations cannot be achieved at the nine mills without major modification of the existing closed biological treatment systems. Further, the incremental removal of chloroform that would occur at these nine mills is not justified in light of the non-water quality impacts that would result from the application of chloroform removal technology. EPA estimated that compliance with proposed chloroform limitations would increase the energy used to operate wastewater treatment systems at these nine mills by over 70 percent.

The Agency also decided to withdraw the proposed NSPS for chloroform because EPA anticipates that chloroform will be effectively controlled at new sources through the application of open biological treatment systems; closed biological treatment systems are now employed at only about 4.7 percent of the existing direct discharging mills.

At proposal, EPA was aware that some wastepapers are contaminated with PCBs which were once used in the manufacture of carbonless copy paper. However, only limited data were available on the discharge and treatability of PCBs in the pulp, paper, and paperboard industry. Thus, PCB effluent limitations were not proposed for those subcategories where wastepaper is processed. Instead, the Agency sought comments and additional data on the discharge of PCBs and explained that EPA would evaluate all available data between proposal and promulgation to determine whether BAT limitations for control of PCBs are appropriate.

After proposal, the Agency obtained all available information on the discharge of PCBs in the pulp, paper, and paperboard industry and determined that PCB-1242 is a pollutant of concern in discharges from mills in the deink subcategory where fine or tissue papers are produced. Therefore, concurrent with the final regulation, EPA proposed BAT effluent limitations and NSPS for control of PCB-1242 in the deink subcategory. The proposed regulation is the subject of another document. (44)

Prior to promulgation, based on the guidance provided in Paragraph 8 of the Settlement Agreement, EPA reexamined the toxic pollutants of potential concern for this industry as they relate to pretreatment standards. Table VI-8 lists those toxic pollutants of potential concern for which the Agency did not establish pretreatment standards and the reasons therefor.

Nonconventional Pollutant Assessment. During the screening and verification programs, EPA investigated discharge levels of 14 additional nonconventional pollutants (xylene, four resin acids, three fatty acids, and six bleach plant derivatives) specific to the pulp, paper, and paperboard industry and ammonia (used at eight mills as a cooking chemical). Table V-32 presents a summary of the verification program results for these nonconventional pollutants. One of the bleach plant derivatives, 9,10-dichlorostearic acid, was detected only once in an internal process sewer sample at a market bleached kraft facility. Therefore, EPA eliminated it from further consideration because it was not detected in final effluent samples at any of 60 mills.

Another nonconventional pollutant, xylene, was detected in significant quantities in the final effluent at only one verification mill, where it was known that xylene was used. Therefore, EPA decided not to establish uniform national regulations for control of xylene in the pulp, paper, and paperboard point source category; the pollutant (a) was detectable at potentially significant levels in the effluent of only one source within the category where the pollutant is uniquely related to only that source or (b) was present in amounts too small to be effectively reduced by technologies known to the Administrator. If the permit issuing authority is aware that xylene is used at a mill, EPA recommends that the permit writer undertake a closer examination of the levels being discharged to determine if xylene should be limited in the NPDES permit.

EPA assessed data on the remaining four resin acids, three fatty acids, and five bleach plant derivatives. Verification program results for raw waste and final effluent discharges were summarized for each compound by subcategory. A similar summary was completed for all of the verification mills where BPT effluent limitations for BOD5 and TSS were attained. Tables VI-9, 10, 11, and 12 present these summaries.

Data available to the Agency show that biological treatment (the technology basis of BPT in those subcategories where high levels of

TABLE VI-8

EXCLUSION OF TOXIC POLLUTANTS OF POTENTIAL CONCERN FROM PRETREATMENT STANDARDS

Toxic Pollutant	Reason for Exclusion
4. benzene	Below treatability in raw waste at all but one mill.
11. 1,1,1-trichloroethane	Below treatability in raw waste at all but one mill.
23. chloroform	Average POTW removal is 61 percent[1] However, the only POTW sampled by EPA that receives wastewater from a mill where chlorine is used to bleach pulp removed 97.8 percent of the raw waste chloroform[1]. Direct discharger removal averages 96.7 percent. Pass through is unlikely.
24. 2-chlorophenol	Below treatability in raw waste at all but one mill.
31. 2,4-dichlorophenol	Below treatability in raw waste at all but one mill.
38. ethylbenzene	Below treatability in raw waste at all but one mill.
47. bromoform	Average raw waste discharge is below treatability
55. naphthalene	Below treatability in raw waste at all but two mills in two different subcategories.
65. phenol	POTW removal is 83 percent[1]. Direct discharger removal ranges from 0 to 100 percent; average removal is approximately 91 percent. Pass through is unlikely.
67. butyl benzyl phthalate	POTW removal is 99 percent[1]. Pass through is unlikely.
68. di-n-butyl phthalate	Below treatability in raw waste at all but three mills in three different subcategories.

TABLE VI-8 (cont.)

70. diethyl phthalate	POTW removal is 99 percent[1]. Pass through is unlikely.
84. pyrene	Average raw waste discharge is below treatability.
85. tetrachloroethylene	Below treatability in raw waste at all but two mills in two different subcategories.
86. toluene	POTW removal is 91 percent[1]. Direct discharger removal ranges from 39.1 to 100 percent. Average removal is approximately 90 percent. Pass through is unlikely.
87. trichloroethylene	Below treatability in raw waste at all but one mill.
106. PCB-1242	POTW removal is comparable to proposed BAT[2]. Pass through is unlikely.
107. PCB-1254	Never used in the manufacture of carbonless copy paper. Found at low levels only periodically.
110. PCB-1248	Never used in the manufacture of carbonless copy paper. Found at low levels only periodically.
111. PCB-1260	Never used in the manufacture of carbonless copy paper. Found at low levels only periodically.
121. cyanide	POTW removal is 61 percent[1]. Direct discharger removal ranges from 31.2 to 91.6 percent; average removal is approximately 70 percent. Pass through is unlikely.
122. lead	Below treatability in raw waste at all but four mills in four different subcategories.

---

[1] Based on information contained in Fate of Priority Pollutants in Publicly Owned Treatment Works, US Environmental Protection Agency, September 1982. (43)

[2] Based on a comparison of information contained in Fate of Priority Pollutants in Publicly Owned Treatment Works, US Environmental Protection Agency, September 1982 (43) and information contained in the Development Document for Proposed Effluent Limitations Guidelines and Standards for Control of Polychlorinated Biphenyls in the Deink Subcategory of the Pulp, Paper and Paperboard Point Source Category, US Environmental Protection Agency, October 1982 (44).

TABLE VI-9

SUMMARY OF INFLUENT CONCENTRATIONS* FOR RESIN AND FATTY ACIDS AND CHLORINATED DERIVATIVES FOR ALL VERIFICATION FACILITIES

	Treatment Type	Abietic 130	Dehydro-abietic 131	Iso-pimaric 132	Pimaric 133	Oleic 134	Lino-leic 135	Lino-lenic 136	Epoxy-stearic 137	Dichloro-stearic 138	1-Chlorodehy-droabietic 139	2-Chlorodehy-droabietic 140	Trichloro-guaiacol 141	Tetrachloro-guaiacol 142	Total
Integrated Segment															
Dissolving Kraft	Biological	11,800	3,500	887	1,357	3,667	2,900	--	817	--	1,433	--	--	--	26,361
Market Bleached Kraft[1]	Biological	13	26	--	--	383	1,320	126	--	--	3	--	--	5	1,876
BCT Bleached Kraft	Biological	1,043	861	107	115	1,084	762	--	--	--	78	3	1	8	4,062
Alkaline-Fine[2]	Biological	470	273	74	63	276	283	71	--	--	44	6	4	7	1,571
Unbleached Kraft															
o Linerboard	Biological	753	470	283	43	337	203	--	--	--	--	--	--	--	2,089
o Bag	Biological	6,983	7,142	770	1,168	3,133	958	1,543	--	--	--	--	--	--	21,697
Semi-Chemical	Biological	257	168	34	36	115	122	98	--	--	--	--	--	--	830
Unbleached Kraft and Semi-Chemical	Biological	1,392	607	547	152	618	441	--	266	--	--	--	--	--	4,023
Dissolving Sulfite Pulp	Biological	1,949	1,000	774	277	1,157	510	--	--	--	161	93	6	4	5,931
Papergrade Sulfite[3]	Biological	137	423	62	25	129	63	58	40	--	123	2	4	1	1,067
Groundwood-Fine Papers	Biological	182	148	29	76	174	337	250	--	--	--	--	--	--	1,196
Integrated Miscellaneous	Biological	1,029	585	374	384	450	290	--	--	--	33	2	--	--	3,147
Secondary Fibers Segment															
Deink															
o Fine Papers	Biological	837	2,267	587	127	967	470	212	--	--	467	6	14	8	5,962
o Newsprint	POTW	3,467	3,700	510	257	1,367	750	167	--	--	--	--	--	--	10,218
o Tissue Papers	Partial Flow, Biological	557	3,267	150	39	400	55	--	--	--	24	--	--	--	4,492
	Biological	513	1,833	193	80	410	178	--	--	--	--	--	--	--	3,207
Tissue From Wastepaper	Primary	203	417	28	43	147	--	--	--	--	--	--	--	--	838
	Biological	54	372	32	12	183	--	--	--	--	--	--	--	--	653
Paperboard From Wastepaper	Primary	407	467	84	41	290	--	--	--	--	--	--	--	--	1,289
	Biological	651	479	128	78	339	63	69	413	--	--	--	--	--	2,220

*Average concentrations µg/l.

[1] Data at one mill were not included due to upset conditions being reflected in the final effluent.

[2] Includes Fine Bleached Kraft and Soda subcategories.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE VI-9 (Continued)

	Treatment Type	Abietic 130	Dehydro-abietic 131	Iso-pimaric 132	Pimaric 133	Oleic 134	Lino-leic 135	Lino-lenic 136	Epoxy-stearic 137	Dichloro-stearic 138	1-Chlorodehy-droabietic 139	2-Chlorodehy-droabietic 140	Trichloro-guaiacol 141	Tetrachloro-guaiacol 142	Total
Wastepaper-Molded Products	Biological	210	453	48	57	493	207	--	--	--	--	--	--	--	1,468
	POTW	633	573	94	--	353	123	--	--	--	--	--	--	--	1,776
Builders' Paper and Roofing Felt	POTW	7,559	2,199	1,164	576	2,237	897	138	--	--	--	--	--	--	14,770
	Primary	--	143	--	--	--	--	--	--	--	--	--	--	--	143
Nonintegrated Segment															
Nonintegrated-Fine Papers	Primary	--	483	--	--	--	--	--	--	--	--	--	--	--	483
	Biological	207	433	39	19	65	67	--	--	--	--	--	--	--	830
Nonintegrated-Tissue Papers	Biological	--	--	--	--	13	--	--	--	--	--	--	--	--	13
	Primary	53	213	37	10	260	--	--	--	--	--	--	--	--	573
Nonintegrated-Lightweight Papers	Biological	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nonintegrated-Filter and Nonwoven Papers	Biological	--	33	--	--	--	--	--	--	--	--	--	--	--	33
Nonintegrated-Paperboard	Biological	748	413	62	25	260	--	--	--	--	--	--	--	--	1,508
Nonintegrated Miscellaneous	Primary w/ Holding Pond	--	14	--	--	--	--	--	--	--	--	--	--	--	14
	Primary	177	174	84	54	55	33	--	--	--	--	--	--	--	577

*Average concentrations µg/l.

TABLE VI-10

SUMMARY OF EFFLUENT CONCENTRATIONS* FOR RESIN AND FATTY ACIDS AND CHLORINATED DERIVATIVES FOR ALL VERIFICATION FACILITIES

	Treatment Type	Abietic 130	Dehydro-abietic 131	Iso-pimaric 132	Pimaric 133	Oleic 134	Lino-leic 135	Lino-lenic 136	Epoxy-stearic 137	Dichloro-stearic 138	1-Chlorodehy-droabietic 139	2-Chlorodehy-droabietic 140	Trichloro-guaiacol 141	Tetrachloro-guaiacol 142	Total
Integrated Segment															
Dissolving Kraft	Biological	1,467	520	380	710	333	170	--	--	--	473	--	--	--	4,053
Market Bleached Kraft[1]	Biological	--	4	--	--	69	55	47	--	--	--	--	--	--	175
BCT Bleached Kraft	Biological	119	123	21	22	17	--	--	--	--	11	1	--	1	315
Alkaline-Fine[2]	Biological	3	5	1	--	41	4	--	--	--	--	--	1	3	58
Unbleached Kraft															
o Linerboard	Biological	10	11	6	1	38	--	--	--	--	--	--	--	--	66
o Bag	Biological	165	85	15	32	70	--	--	--	--	--	--	--	--	367
Semi-Chemical	Biological	39	14	7	4	33	14	35	--	--	9	13	--	--	168
Unbleached Kraft and Semi-Chemical	Biological	710	235	187	106	407	59	--	113	--	--	--	--	--	1,817
Dissolving Sulfite Pulp	Biological	383	171	115	31	81	8	--	--	--	108	--	--	2	899
Papergrade Sulfite[2]	Biological	76	246	17	17	70	34	--	7	--	39	1	2	--	509
Groundwood-Fine Papers	Biological	7	26	3	5	23	72	--	--	--	--	--	--	--	136
Integrated Miscellaneous	Biological	61	96	31	25	38	1	--	--	--	1	--	--	--	253
Secondary Fibers Segment															
Deink															
o Fine Papers	Biological	12	49	5	--	49	--	99	--	--	--	--	14	9	237
o Newsprint	POTW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
o Tissue Papers	Partial Flow, Biological	97	343	18	--	590	--	--	--	--	14	--	--	--	1,062
	Biological	72	253	13	--	243	--	--	--	--	--	--	--	--	581
Tissue From Wastepaper	Primary	84	250	--	--	25	--	--	--	--	--	--	--	--	359
	Biological	--	20	--	--	193	--	--	--	--	--	--	--	--	213
Paperboard From Wastepaper	Primary	--	96	8	--	--	--	--	--	--	--	--	--	--	104
	Biological	19	55	3	--	78	--	5	--	--	--	--	--	--	160
Wastepaper-Molded Products	Biological	7	61	--	--	48	--	--	--	--	--	--	--	--	116
	POTW	--	--	--	--	--	--	--	--	--	--	--	--	--	--

TABLE VI-10 (Continued)

SUMMARY OF EFFLUENT CONCENTRATIONS* FOR RESIN AND FATTY ACIDS
AND CHLORINATED DERIVATIVES FOR ALL VERIFICATION FACILITIES

	Treatment Type	Abietic 130	Dehydro-abietic 131	Iso-pimaric 132	Pimaric 133	Oleic 134	Lino-leic 135	Lino-lenic 136	Epoxy-stearic 137	Dichloro-stearic 138	1-Chlorodehy-droabietic 139	2-Chlorodehy-droabietic 140	Trichloro-guaiacol 141	Tetrachloro-guaiacol 142	Total
Builders' Paper and Roofing Felt	POTW	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	Primary	--	117	--	--	--	--	--	--	--	--	--	--	--	117
Nonintegrated Segment															
Nonintegrated-Fine Papers	Primary	--	93	--	--	--	--	--	--	--	--	--	--	--	93
	Biological	4	45	--	--	--	--	--	--	--	--	--	--	--	49
Nonintegrated-Tissue Papers	Primary	--	98	2	--	27	--	--	--	--	--	--	--	--	127
	Biological	--	--	--	--	27	--	--	--	--	--	--	--	--	27
Nonintegrated-Lightweight Papers	Biological	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nonintegrated-Filter and Nonwoven Papers	Biological	--	--	--	--	--	3	--	--	--	--	--	--	--	3
Nonintegrated-Paperboard	Biological	--	64	--	--	--	--	--	--	--	--	--	--	--	64
Nonintegrated Miscellaneous	Primary w/ Holding Pond	--	200	--	--	--	--	--	--	--	--	--	--	--	200
	Primary	8	67	11	--	8	--	--	--	--	--	--	--	--	94

*Average concentration µg/l.

[1] Data at one mill were not included due to upset conditions being reflected in the final effluent.

[2] Includes Fine Bleached Kraft and Soda subcategories.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE VI-11

SUMMARY OF INFLUENT CONCENTRATIONS* FOR RESIN AND FATTY ACIDS
AND CHLORINATED DERIVATIVES FOR VERIFICATION MILLS MEETING BPT EFFLUENT LIMITATIONS

	Treatment Type	Abietic 130	Dehydro-abietic 131	Iso-pimaric 132	Pimaric 133	Oleic 134	Lino-leic 135	Lino-lenic 136	Epoxy-stearic 137	Dichloro-stearic 138	1-Chlorodehy-droabietic 139	2-Chlorodehy-droabietic 140	Trichloro-guaiacol 141	Tetrachloro-guaiacol 142	Total
Integrated Segment															
Market Bleached Kraft[1]	Biological	13	26	--	--	383	1,320	126	--	--	3	--	--	5	1,876
BCT Bleached Kraft	Biological	350	547	51	58	533	257	--	--	--	116	--	--	--	1,912
Alkaline-Fine[2]	Biological	470	273	74	63	276	283	71	--	--	44	6	4	7	1,571
Unbleached Kraft o Linerboard	Biological	753	470	283	43	337	203	--	--	--	--	--	--	--	2,089
Semi-Chemical	Biological	--	153	29	11	69	--	--	--	--	--	--	--	--	262
Unbleached Kraft and Semi-Chemical	Biological	1,633	750	590	243	937	730	--	--	--	--	--	--	--	4,883
Papergrade Sulfite[3]	Biological	--	18	--	--	97	--	--	--	--	--	--	--	--	115
Groundwood-Fine Papers	Biological	305	245	55	76	38	--	--	--	--	--	--	--	--	719
Integrated Miscellaneous	Biological	2,700	1,400	1,020	747	1,280	307	--	--	--	54	--	--	--	7,508
Secondary Fibers Segment															
Deink															
o Fine Papers	Biological	837	2,267	587	127	967	470	212	--	--	467	6	14	8	5,962
o Tissue Papers	Biological	513	1,833	193	80	410	178	--	--	--	--	--	--	--	3,207
Tissue From Wastepaper	Primary	203	417	28	43	147	--	--	--	--	--	--	--	--	838
	Biological	54	372	32	12	183	--	--	--	--	--	--	--	--	653
Paperboard From Wastepaper	Biological	426	357	173	150	342	--	--	413	--	--	--	--	--	1,861
Nonintegrated Segment															
Nonintegrated-Fine Papers	Primary	--	483	--	--	--	--	--	--	--	--	--	--	--	483
	Biological	207	433	39	19	65	67	--	--	--	--	--	--	--	830
Nonintegrated-Tissue Papers	Primary	53	213	37	10	260	--	--	--	--	--	--	--	--	573
	Biological	--	--	--	--	13	--	--	--	--	--	--	--	--	13
Nonintegrated-Filter and Nonwoven Papers	Biological	--	33	--	--	--	--	--	--	--	--	--	--	--	33
Nonintegrated-Paperboard	Biological	1,477	667	117	25	260	--	--	--	--	--	--	--	--	2,546

*Average concentrations µg/l

[1] Data at one mill were not included due to upset conditions being reflected in the final effluent.

[2] Includes Fine Bleached Kraft and Soda subcategories.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE VI-12

SUMMARY OF EFFLUENT CONCENTRATIONS* FOR RESIN AND FATTY ACIDS AND CHLORINATED DERIVATIVES FOR VERIFICATION MILLS MEETING BPT EFFLUENT LIMITATIONS

	Treatment Type	Abietic 130	Dehydro-abietic 131	Iso-pimaric 132	Pimaric 133	Oleic 134	Lino-leic 135	Lino-lenic 136	Epoxy-stearic 137	Dichloro-stearic 138	1-Chlorodehy-droabietic 139	2-Chlorodehy-droabietic 140	Trichloro-guaiacol 141	Tetrachloro-guaiacol 142	Total
Integrated Segment															
Market Bleached Kraft[1]	Biological	--	4	--	--	69	55	47	--	--	--	--	--	--	175
BCT Bleached Kraft	Biological	55	122	19	29	15	--	--	--	--	5	--	--	--	245
Alkaline-Fine[2]	Biological	3	5	1	--	41	4	--	--	--	--	--	1	3	58
Unbleached Kraft Linerboard	Biological	10	11	6	1	38	--	--	--	--	--	--	--	--	66
Semi-Chemical	Biological	--	2	--	--	11	--	--	--	--	--	--	--	--	13
Unbleached Kraft and Semi-Chemical	Biological	830	263	203	167	613	118	--	--	--	--	--	--	--	2,194
Papergrade Sulfite[3]	Biological	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Groundwood-Fine Papers	Biological	12	36	5	5	11	--	--	--	--	--	--	--	--	69
Integrated Miscellaneous	Biological	143	105	67	42	66	--	--	--	--	--	--	--	--	423
Secondary Fibers Segment															
Deink															
o Fine Papers	Biological	12	49	5	--	49	--	99	--	--	--	--	14	9	237
o Tissue Papers	Biological	72	253	13	--	243	--	--	--	--	--	--	--	--	581
Tissue From Wastepaper	Primary	84	250	--	--	25	--	--	--	--	--	--	--	--	359
	Biological	--	20	--	--	193	--	--	--	--	--	--	--	--	213
Paperboard From Wastepaper	Biological	16	42	5	--	70	--	--	--	--	--	--	--	--	133
Nonintegrated Segment															
Nonintegrated-Fine Papers	Primary	--	93	--	--	--	--	--	--	--	--	--	--	--	93
	Biological	4	45	--	--	--	--	--	--	--	--	--	--	--	49
Nonintegrated-Tissue Papers	Primary	--	98	2	--	27	--	--	--	--	--	--	--	--	127
	Biological	--	--	--	--	27	--	--	--	--	--	--	--	--	27
Nonintegrated-Filter and Nonwoven Papers	Biological	--	--	--	--	--	3	--	--	--	--	--	--	--	3
Nonintegrated-Paperboard	Biological	--	128	--	--	--	--	--	--	--	--	--	--	--	128

*Average concentrations μg/l

[1] Data at one mill were not included due to upset conditions being reflected in the final effluent.

[2] Includes Fine Bleached Kraft and Soda subcategories.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

resin acids, fatty acids, and bleach plant derivatives are generated) is very effective in reducing raw waste loadings of resin acids, fatty acids, and bleach plant derivatives (see Table VI-13). Almost no data are available for potential BAT treatment technologies such as foam separation, chemically assisted clarification, ion exchange, or activated carbon. In addition, analytical methods have not been developed for measuring these nonconventional pollutants. For the above reasons, EPA cannot establish BAT effluent limitations guidelines and NSPS for control of resin acids, fatty acids, and bleach plant derivatives on a national basis.

Wastewaters discharged from mills in the pulp, paper, and paperboard industry are generally nutrient deficient. It is normally necessary to add nutrients, such as ammonia and phosphorus, to ensure efficient operation of biological treatment systems. However, there are eight mills in three subcategories where ammonia-based cooking chemicals are used in the pulping process. The Agency did not propose establishment of ammonia limitations because there were very limited data available on ammonia discharges from these eight mills. EPA sought additional data and requested comments on the necessity for establishment of uniform national standards for control of ammonia in the pulp, paper, and paperboard industry.

Some commenters stated that ammonia should not be regulated on a uniform national basis because of the absence of wide-spread receiving water quality problems from routine industrial discharges of ammonia. They stated that ammonia occurs naturally in the environment, is readily metabolized to nitrite and nitrate, and, therefore, is best regulated on a case-by-case basis. Other commenters urged the Agency to collect additional data on the level of ammonia discharges and applicable treatment technologies to determine whether effluent limitations were necessary.

After reviewing the comments and all available ammonia data, EPA decided not to establish ammonia limitations. In reaching that decision, the Agency confirmed that there are only eight mills in three subcategories where ammonia-based cooking chemicals are used in the pulping process. Resulting ammonia raw waste concentrations range from 20 to 340 mg/l. After application of BPT, about 12 to 32 mg/l of ammonia remain, depending on the subcategory considered. When BPT effluent limits are met, about 3.6 million kg (8.0 million pounds) per year of ammonia are removed from industry raw wastes.

EPA identified two technologies capable of removing additional ammonia from pulp, paper, and paperboard industry wastewaters: (a) conversion of existing biological treatment systems to operate in a nitrification mode and (b) conversion to the use of a new chemical base (i.e., sodium or magnesium). These technologies are discussed in detail in Sections VII and VIII and Appendix A of this document.

The Agency investigated the ammonia removal capability of these technologies and also estimated the economic impact that would result from establishing ammonia limitations. Uncertainties exist in the

TABLE VI-13

REMOVALS OF RESIN AND FATTY ACIDS
AND CHLORINATED DERIVATIVES

Subcategory	Treatment Type	All Verification Mills			Verification Mills Meeting BPT Limitations		
		Concentration (µg/l)		Percent	Concentration (µg/l)		Percent
		Influent	Effluent	Removal	Influent	Effluent	Removal
Integrated Segment							
Dissolving Kraft	Biological	26,361	4,053	85	--	--	--
Market Bleached Kraft[1]	Biological	1,876	175	91	1,876	175	91
BCT Bleached Kraft	Biological	4,062	315	92	1,912	245	87
Alkaline-Fine[2]	Biological	1,571	58	96	1,571	58	96
Unbleached Kraft							
o Linerboard	Biological	2,089	66	97	2,089	66	97
o Bag	Biological	21,697	367	98	--	--	--
Semi-Chemical	Biological	830	168	80	282	13	93
Unbleached Kraft and Semi-Chemical	Biological	4,023	1,817	55	4,883	2,194	55
Sulfite Dissolving Pulp	Biological	5,931	899	85	--	--	--
Papergrade Sulfite[3]	Biological	1,067	509	52	115	0	100
Groundwood-Fine Papers	Biological	1,196	136	89	719	69	90
Integrated Miscellaneous	Biological	3,147	253	92	7,908	423	94
Secondary Fibers Segment							
Deink							
o Fine Papers	Biological	5,962	237	96	5,962	237	96
o Newsprint	POTW	10,218	--	--	--	--	--
o Tissue Papers	Partial Flow, Biological	4,492	1,062	76	--	--	--
Tissue From Wastepaper	Biological	3,207	381	81	3,207	381	82
	Primary	838	359	57	838	359	57
Paperboard From Wastepaper	Biological	653	213	67	653	213	67
	Primary	1,289	104	92	--	--	--
Wastepaper-Molded Products	Biological	2,220	160	93	1,861	133	93
	Biological	1,468	116	92	--	--	--
Builders' Paper and Roofing Felt	POTW	1,776	--	--	--	--	--
	POTW	14,770	--	--	--	--	--
	Primary	143	117	18	--	--	--
Nonintegrated Segment							
Nonintegrated-Fine Papers	Primary	483	93	81	483	93	81
	Biological	830	49	94	830	49	94
Nonintegrated-Tissue Papers	Primary	573	127	72	573	127	78
	Biological	13	27	0	13	27	0
Nonintegrated-Lightweight Papers	Biological	--	--	--	--	--	--
Nonintegrated-Filter and Nonwoven Papers	Biological	33	3	91	33	3	91
Nonintegrated-Paperboard	Biological	1,308	64	96	2,346	128	95
Nonintegrated Miscellaneous	Primary w/Holding Pond[4]	14	200	0	--	--	--
	Primary	577	94	84	--	--	--

---

[1] Data at one mill were not included due to upset conditions being reflected in the final effluent.

[2] Includes Fine Bleached Kraft and Soda subcategories.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

[4] Treatment system detention time is three days.

modifications required to convert existing pulp, paper, and paperboard biological treatment systems to operate in a nitrification mode (i.e., proper detention time, sludge age, and operating temperature). Therefore, the Agency assumed that ammonia limitations, if established, would be attained through conversion to a different (non-ammonia) chemical base.

The Agency estimates that an additional 2.02 million kg (4.45 million pounds) per year of ammonia could be removed from wastewater discharges from the eight mills where ammonia - based cooking chemicals are used. Capital and total annual costs at the eight mills would be $120 million and $36.3 million, respectively (1978 dollars). These costs would result in production cost increases ranging from 2.9 to 15.4 percent and might cause the closure of four of the eight mills.

Because of these projected severe economic impacts, the Agency determined that establishment of uniform national standards for control of ammonia is unwarranted. If required to protect water quality, ammonia limitations are best established on a case-by-case basis.

SECTION VII

CONTROL AND TREATMENT TECHNOLOGY

INTRODUCTION

This section describes the control and treatment technologies in use and available for application at pulp, paper, and paperboard mills to reduce wastewater and/or wastewater pollutant discharge. There are two major technology approaches that may be employed: (a) in-plant production process controls and (b) effluent treatment technology. Production process controls are those technologies implemented to reduce the effluent volume and pollutant loading discharged from the manufacturing facility. Effluent treatment technologies are those end-of-pipe treatment systems used to reduce the discharge of pollutants contained in mill effluents. In most instances, pollution abatement programs developed for use at individual mills include both approaches. In some cases, production process controls and effluent treatment technologies can yield comparable results. For example, suspended solids removal equipment may be employed internally within a mill to allow for reuse of clarified water in the process and recovered solids in the product; at another mill, end-of-pipe technology may be relied on to a greater extent to produce similar effluent characteristics.

PRODUCTION PROCESS CONTROLS COMMONLY EMPLOYED BY THE PULP, PAPER, AND PAPERBOARD INDUSTRY

Many alternative approaches have been taken within the pulp, paper, and paperboard industry in implementing process controls to reduce effluent volume and waste loads. In earlier development documents, technologies were identified that are commonly employed within the industry to control pulping, bleaching, washing, liquor recovery, and papermaking processes.(45)(46)(47)(48) Tables VII-1 and 2 present the production process control technologies on which BPT and BAT effluent limitations were based. Pollution abatement is not the sole driving force for implementation of production process controls. In many cases, the concern for consistent production of high quality products with minimum loss of substrate results in the development of process controls that reduce raw waste loadings. Production process controls have always been a part of integrated pulp and papermaking operations, their primary function being the control of product characteristics and improvement of process economics.

As part of the data request program, production process control information was received for a total of 644 mills, 610 of which were still in operation as of April 12, 1982. Production process controls at these mills are generally applied in eight specific mill areas and also include provision for the recycle of effluent. The following discussions relate to production process controls applicable to the:

- woodyard/woodroom,

TABLE VII-1
PRODUCTION PROCESS CONTROL TECHNOLOGIES IDENTIFIED AS THE BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

- High Level Alarms on Tanks
- Decker Filtrate for Sulfite Pit Dilution or Vacuum Washer Showers
- Prehydrolysate Disposal by Burning
- Evaporator Condensates for Brown Stock Washer Showers
- Recook Screen Room Rejects
- Use of CLO_2 Waste Acid for Tall Oil Manufacture or Add to Black Liquor for Recovery
- Use of Green Liquor Dregs Filter
- White Water Showers for Wire Cleaning
- Broke Storage and Overflow Prevention
- Install Saveall
- Use of Mill Wastewater in Woodyard
- Knot Collection Disposal or Reuse
- Turpentine Collection
- Soap Collection
- Sulfite Red Liquor Evaporation and Disposal
- Countercurrent Washing -- Deink
- Close-up Screen Room with Reuse of Decker Filtrate
- Jump State Countercurrent Wash in Bleach Plant with Reuse of Chlorination Filtrate
- Reuse Kiln Scrubber Water
- Evaporator Condensate Used as Causticizing Makeup
- White Water Storage During Upsets and Reuse as Pulper Dilution Water

TABLE VII-2

PRODUCTION PROCESS CONTROL TECHNOLOGIES IDENTIFIED AS THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

- Cooling Water Segregation and Reuse
- Dry Barking
- Evaporator Surface Condenser
- Evaporator Boilout Tank
- Caustic Area Spill Collection
- Reuse Vacuum Pump Seal Water
- Stock and Liquor Spill Collection
- Lime Mud Pond
- Filter and Reuse Press Effluent
- Paper Mill Stock Spill Collection
- High Pressure Showers for Wire and Felt Cleaning

- pulp mill,
- washers/screen room,
- bleachery,
- evaporation and recovery area,
- liquor preparation area,
- papermill,
- steam plant and utilities,
- recycle of effluent, and
- substitution of chemicals.

In order to comply with BPT effluent limitations, some degree of production process control was implemented at most mills. In this section, some specific production process controls that are applicable to each industry subcategory are described. Additional controls that may be applicable at individual mills, rather than all mills in a subcategory, are also described. Table VII-3 summarizes the control items that have been identified and discussed.

Woodyard/Woodroom

Production process controls that reduce raw waste loading in woodroom area include: a) conversion to mechanical or dry systems or close-up of wet operations and b) the segregation and reuse or direct discharge of uncontaminated cooling waters. These controls, their applicability within the various subcategories, and their general effectiveness are described below.

Close-Up or Dry Operation. This production process control is commonly practiced at most mills; however, it has not been commonly employed at mills in the dissolving sulfite pulp and groundwood-fine papers subcategories. For mills in the dissolving sulfite pulp subcategory, discharge of wastewater from hydraulic barking systems can be eliminated through installation of a collection tank and cleaning system to enable recycle of water; pulp mill wastewater can be used as make-up to the system. At mills in the groundwood-fine papers subcategory, conversion to dry barking and the use of mechanical conveyors is possible. In colder climates it may be necessary to use steam in the barking drums. These controls are illustrated in Figures VII-1 and VII-2.

Application of these controls in the barking area of the woodroom will result in reduced water use and a lower water content in the bark. With drier bark, combustion (and heat reclamation) is possible without further processing.

TABLE VII-3

PRODUCTION PROCESS CONTROL TECHNOLOGIES AVAILABLE FOR REDUCTION OF EFFLUENT VOLUME AND POLLUTANT LOADINGS

Woodyard/Woodroom
  - Closeup or dry operation
  - Segregate cooling water

Pulp Mill
  - Reuse blow condensates
  - Reduce thickener overflow (groundwood)
  - Spill collection

Brown Stock Washers and Screen Room
  - Add third or fourth stage washer
  - Recycle more decker filtrate
  - Cleaner rejects to landfill

Bleaching Systems
  - Countercurrent or jumpstage wash
  - Evaporate caustic extraction stage filtrate

Evaporation and Recovery
  - Recycle of condensates
  - Replace barometric condenser with surface condenser
  - Boilout tank
  - Neutralize spent sulfite liquor
  - Segregate cooling water
  - Spill collection

Liquor Preparation Area
  - Installation of green liquor dregs filter
  - Lime mud pond

Papermill
  - Spill collection
  - Improvement of savealls
  - Use of high pressure showers for wire and felt cleaning
  - Whitewater use for vacuum pump sealing
  - Papermachine whitewater use on wire cleaning showers
  - Whitewater storage for upsets and pulper dilution
  - Recycle of press water
  - Reuse of vacuum pump water
  - Additional broke storage
  - Installation of wet lap machines or other screening devices
  - Segregate cooling water
  - Cleaner rejects to landfill
  - Fourth stage cleaners

Steam Plant and Utility Areas
  - Segregate cooling water
  - Lagoon for boiler blowdown and backwash waters

Recycle of Treated Effluent

Chemical Substitution

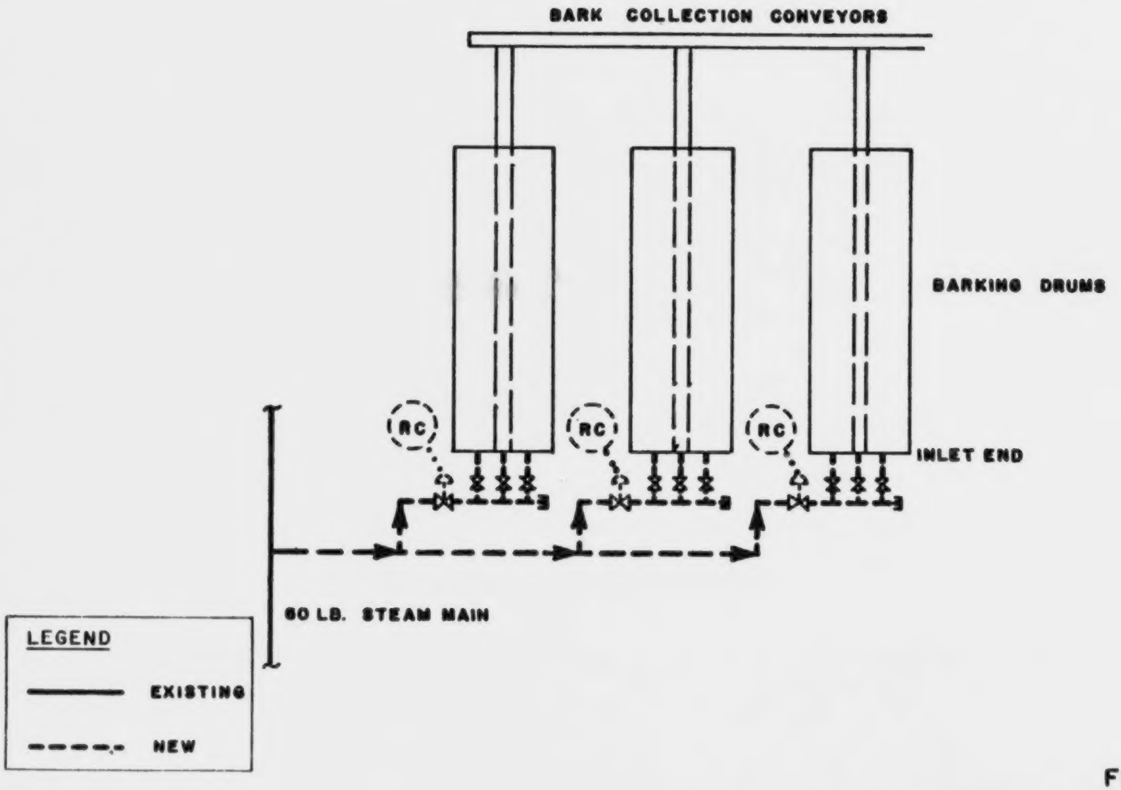

BARK COLLECTION CONVEYORS
BARKING DRUMS
INLET END
RC
RC
RC
60 LB. STEAM MAIN
LEGEND
EXISTING
NEW

FIGURE VII - 1
CONVERT HYDRAULIC BARKING
SYSTEM TO DRY SYSTEM

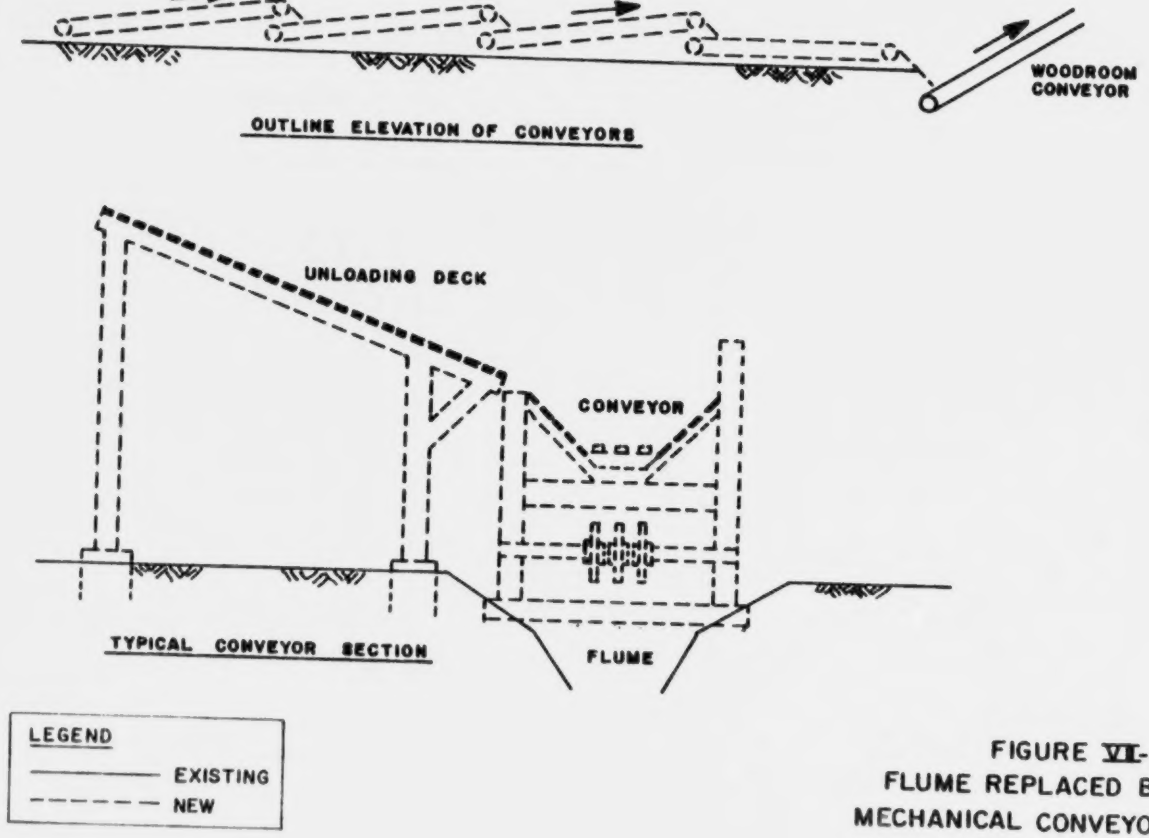

WOODROOM CONVEYOR
OUTLINE ELEVATION OF CONVEYORS
UNLOADING DECK
CONVEYOR
FLUME
TYPICAL CONVEYOR SECTION
LEGEND
EXISTING
NEW

FIGURE VII- 2
FLUME REPLACED BY
MECHANICAL CONVEYOR

Close-up of the woodroom by conversion to dry debarking or a closed-cycle hydraulic system typically results in flow reductions of 8.3 to 12.5 kl/kkg (2 to 3 kgal/t) and TSS reductions in the range of 5 to 10 kg/kkg (10 to 20 lb/t).(28)(49)(50) Factors affecting the level of reduction are the source of water used in the woodroom, the type of barking operation employed, the type of wood processed, seasonal factors, and the ultimate disposal technique.

Segregation of Cooling Water. This control item involves the collection of water used for motor, chip blower, and bearing cooling. This non-contact cooling water can be returned to an existing water collection tank. At mills in some subcategories, this control could also include the return of condensate from the heating system to the steam plant through a separate line. The technology is illustrated in Figure VII-3.

Woodroom non-contact cooling water segregation has been neglected at most mills in the integrated subcategories. It is designated as an applicable production process control technology in the integrated subcategories where woodrooms are employed. Its implementation can result in a measurable flow reduction and significant energy savings. Segregation of cooling water via a separate discharge can result in effluent flow reduction in the range of 1.3 to 4.2 kl/kkg (0.3 to 1.0 kgal/t), depending reduction ranges from about 1.3 to 4.2 kl/kkg (0.3 to 1.0 kgal/t), depending on the subcategory. Little reduction in BOD_5 or TSS raw waste loads result from application of this technology.

Pulp Mill

Production process controls that reduce raw waste loadings in the pulp mill area include: a) reuse of digester relief and blow condensates, b) reduction of groundwood thickener overflow, and c) spill collection in the brown stock, digester, and liquor storage areas. These controls and their applicability are described below.

Reuse Relief and Blow Condensates. Digester relief and blow condensates may be major contributors to the total BOD_5 discharge from a mill. Particularly with continuous digesters, the relatively small flows are highly contaminated with foul smelling organic mercaptans and other organic compounds. Figure VII-4 illustrates a system for reusing blow condensates. This control is an applicable technology for all of the kraft and soda subcategories. Digester blow condensate is collected in a tank and pumped to the area of greatest benefit. The collection tank should be equipped with a conductivity alarm to alert the operator of unusually strong condensate. Areas where blow condensates can be reused include: (a) addition at the salt cake dissolving tank and (b) use at the lime kiln for mud washing.

If digester condensates, including relief condensates, are stripped or further treated (i.e., reverse osmosis) to reduce BOD_5, they can be reused in other process areas including (a) addition at the first

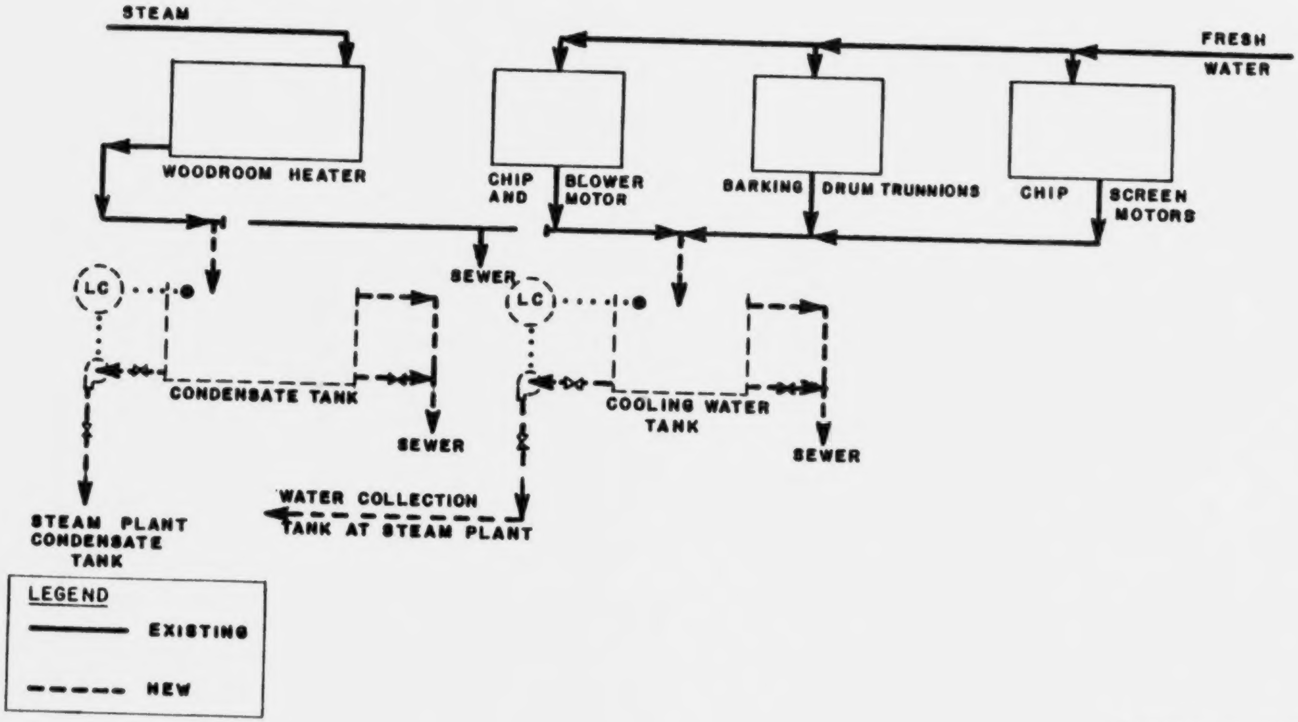

STEAM
WOODROOM HEATER
FRESH WATER
CHIP AND BLOWER MOTOR
BARKING DRUM TRUNNIONS
CHIP SCREEN MOTORS
SEWER
LC
CONDENSATE TANK
SEWER
LC
COOLING WATER TANK
SEWER
STEAM PLANT CONDENSATE TANK
WATER COLLECTION TANK AT STEAM PLANT
LEGEND
EXISTING
NEW

FIGURE VII-3
SEGREGATE WOODROOM NON-CONTACT
COOLING WATER AND CONDENSATE

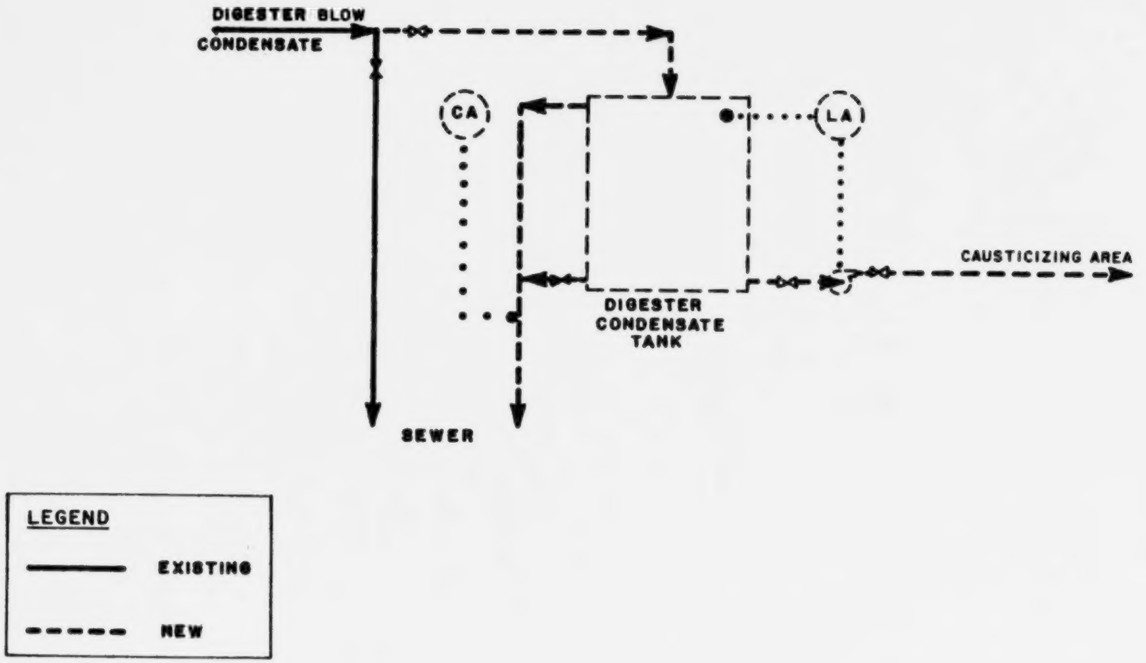

DIGESTER BLOW CONDENSATE
CA
LA
CAUSTICIZING AREA
DIGESTER CONDENSATE TANK
SEWER
LEGEND
EXISTING
NEW

FIGURE VII-4
REUSE OF DIGESTER BLOW CONDENSATE

shower of the last stage brown stock washer or (b) addition directly to the black liquor.

Wastewater BOD5 reductions ranging from 0.9 to 3.0 kg/kkg (1.8 to 6.0 lb/t) can be achieved by incorporating digester relief and blow condensates back into the black liquor recovery cycle.(51)(52)(53) Wastewater reduction at alkaline (kraft and soda) pulp mills through the reuse of increasingly dirtier condensates to replace fresh water results in higher concentrations of volatile organic sulfur compounds in wash water and dilution water. While a net reduction in BOD5 may result, the possibility of releasing these volatile compounds through brown stock washer vents, screening operations, and smelt tank dissolving operations is increased.

Until recently, emission regulations dealt only with the particulate and TRS emissions from the recovery furnace itself. With an increased concern for reduction of overall emission levels, a higher degree of scrubbing, collection, and combustion or disposal of volatile organics may have to be considered prior to implementation of condensate reuse techniques.

Reduce Groundwood Thickener Overflow. At a typical mill in the groundwood-fine papers subcategory, excess thickener filtrate overflows to the sewer at a rate of up to 16.7 kl/kkg (4.0 kgal/t) of pulp produced.(54) This overflow represents a small source of fiber loss and contributes 5.0 kg/kkg (10.0 lb/t) of TSS at a typical mill. Modifications shown in Figure VII-5 can be implemented to close up the white water system, essentially eliminating thickener filtrate overflow to the sewer. A small bleed would be maintained to control the build-up of pulp fines in the final accepted groundwood. Water make-up to the groundwood system would be excess papermachine white water. A heat exchanger would be required during the warmer months of the year to control heat build-up in the filtrate. Fresh water used as cooling water in the heat exchanger would subsequently be returned as make-up to the papermachine systems or discharged via the thermal sewer to balance mill white water heat load.

Spill Collection. Improved spill collection systems can be employed in the digester, liquor storage, and brown stock areas. A system designed to recover leaks, spills, dumps, and weak liquor overflows could result in a recovery of approximately 1.5 to 3.5 kg/kkg (3.0 to 7.0 lb/t) of BOD5.(55) In the brown stock area, the combination of stock and liquor spills would generally be combined with the brown stock entering the first stage washer vat. This control is designated as an applicable technology in 10 subcategories. A pulp mill liquor spill system is illustrated in Figure VII-6.

A separate spill collection system can be employed using a sump in conjunction with conductivity measurements to detect and collect any leaks, spills, or overflows from the pulp mill digester and liquor storage tanks. Any liquor recovered could be diverted to its appropriate tank or to a spare liquor tank. This technology is considered applicable for the dissolving, market, BCT (paperboard,

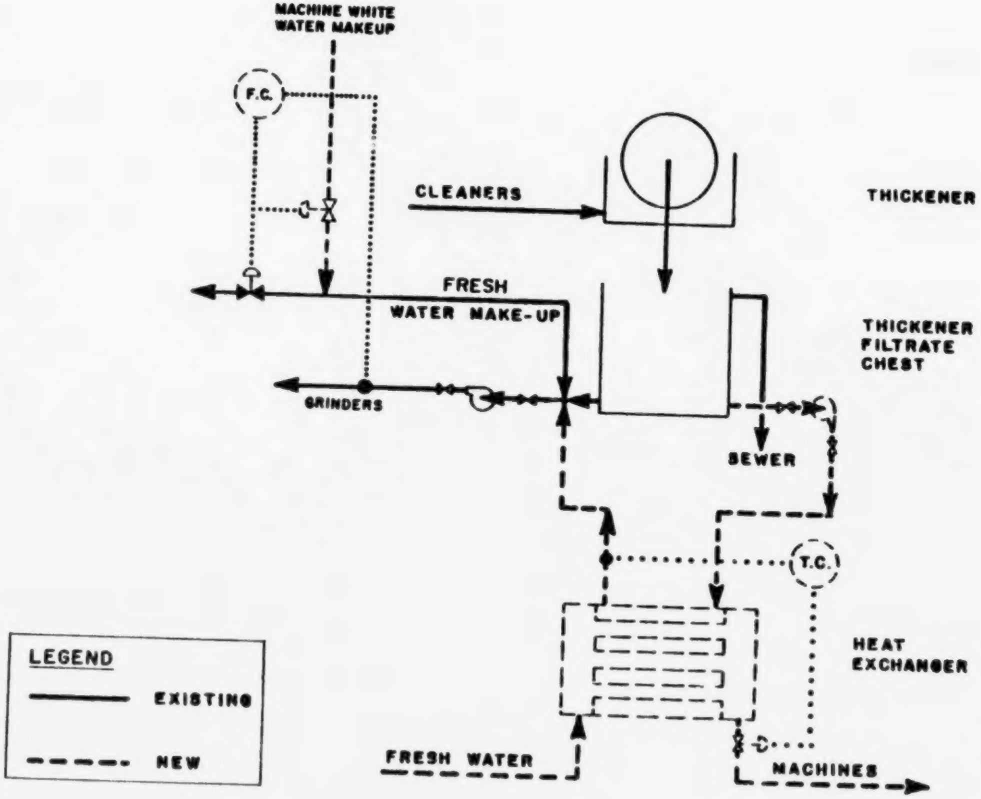

MACHINE WHITE WATER MAKEUP
F.C.
CLEANERS
THICKENER
FRESH WATER MAKE-UP
THICKENER FILTRATE CHEST
GRINDERS
SEWER
T.C.
HEAT EXCHANGER
FRESH WATER
MACHINES
LEGEND
EXISTING
NEW

FIGURE VII-5
REDUCE GROUNDWOOD
THICKENER FILTRATE OVERFLOW

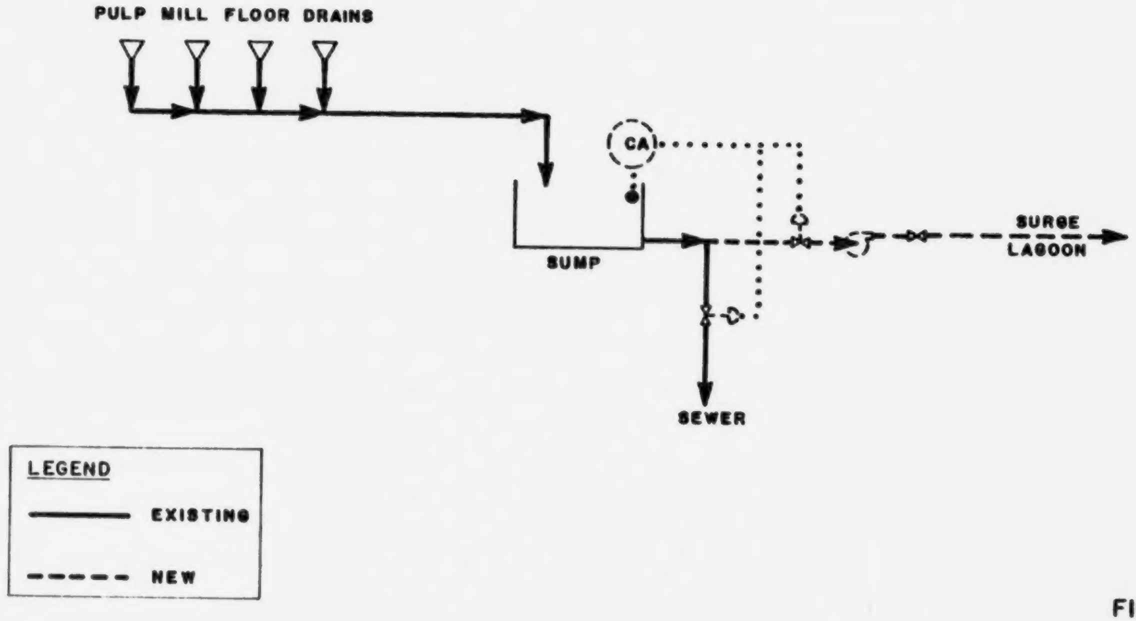

PULP MILL FLOOR DRAINS
CA
SUMP
SEWER
SURGE
LAGOON
LEGEND
EXISTING
NEW

FIGURE VII-6
PULP MILL SPILL COLLECTION
DIGESTER AREA

coarse, and tissue), and fine bleached kraft and soda subcategories; modified systems could also be used in the three sulfite and some groundwood and deink subcategories.

Brown Stock Washers and Screen Room

Production process controls that reduce raw waste loadings in the washer and screen room areas include: a) addition of a third or fourth stage washer or improved washing efficiency by replacement with a properly sized system, b) recycle of more decker filtrate, and c) discharge of cleaner rejects to landfill.

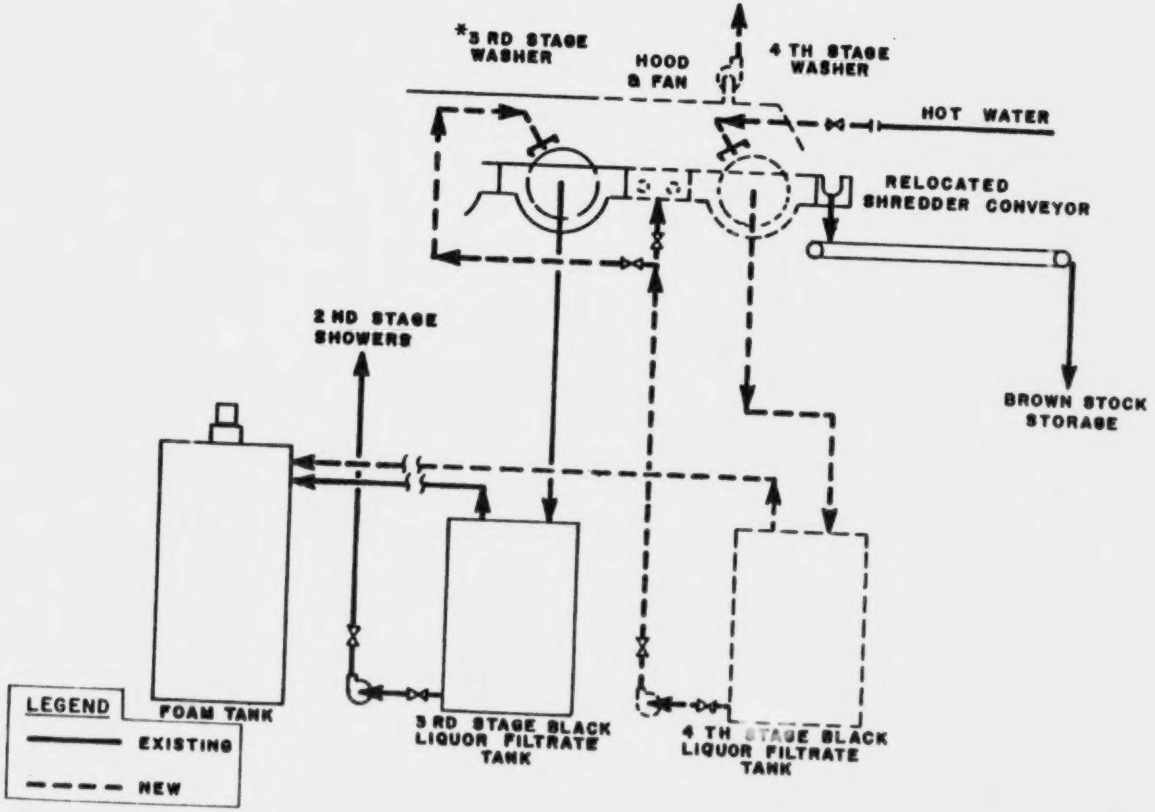
Addition of a Third or Fourth Stage Washer. This control is applicable to mills in the kraft, soda, semi-chemical, both papergrade sulfite, and deink (newsprint product sector) subcategories. The control includes the addition of a fourth-stage washer to all kraft and soda washing lines and a third stage washer to all semi-chemical and papergrade sulfite washing lines. The addition of another washer stage is illustrated in Figure VII-7. This control is primarily a BOD5 reduction measure as dissolved solids losses from the pulping operation are reduced.

Improved washing facilitates bleaching and results in lower bleaching chemical costs. In terms of raw waste load, the main effect is a reduction in BOD5 ranging from about 2.5 kg/kkg (5.0 lb/t) for dissolving kraft mills to as much as 4.0 kg/kkg. (56)(57)(58)

Recycle of More Decker Filtrate. This control item was considered in the establishment of BPT effluent limitations. It is generally applicable to the alkaline (kraft and soda), groundwood, and deink subcategories. Tightening up by using decker filtrate on brown stock washer showers can substantially reduce decker filtrate overflow to the sewer, thus reducing effluent flow and BOD5. Efficient washing on the decker is required to reduce liquor carry-over to bleaching. At many mills in the subcategories mentioned, a considerable quantity of decker filtrate is reused in the screen room as dilution water. A schematic of this control is shown in Figure VII-8.

Typically, reductions of about 4.2 kl/kkg (1.0 kgal/t) of flow and 0.5 to 1.0 kg/kkg (1.0 to 2.0 lb/t) of BOD5 can be realized through implementation of this production process control.(59)(60) Use of this technology requires a detailed study at each mill; the efficiency of the existing washing and screening systems should be taken into account prior to further modification. This production process control is now being practiced to a limited degree and can be considered as an applicable control technology at new source mills.

Cleaner Rejects to Landfill. Centricleaner rejects and continuous screen rejects from the screen room are generally sewered directly and processed in the wastewater treatment plant. Most of these rejects are removed in the primary clarifier and handled in the solids dewatering system; primary solids are often mixed with solids from the secondary clarifier. Dry collection of screen and cleaner rejects


*3 RD STAGE WASHER
HOOD & FAN
4 TH STAGE WASHER
HOT WATER
RELOCATED SHREDDER CONVEYOR
BROWN STOCK STORAGE
2 ND STAGE SHOWERS
FOAM TANK
3 RD STAGE BLACK LIQUOR FILTRATE TANK
4 TH STAGE BLACK LIQUOR FILTRATE TANK
LEGEND
EXISTING
NEW

* ILLUSTRATION ASSUMES EXISTENCE OF THREE STAGES OF WASHING

FIGURE VII-7
ADDITION OF THIRD OR FOURTH STAGE PULP WASHER

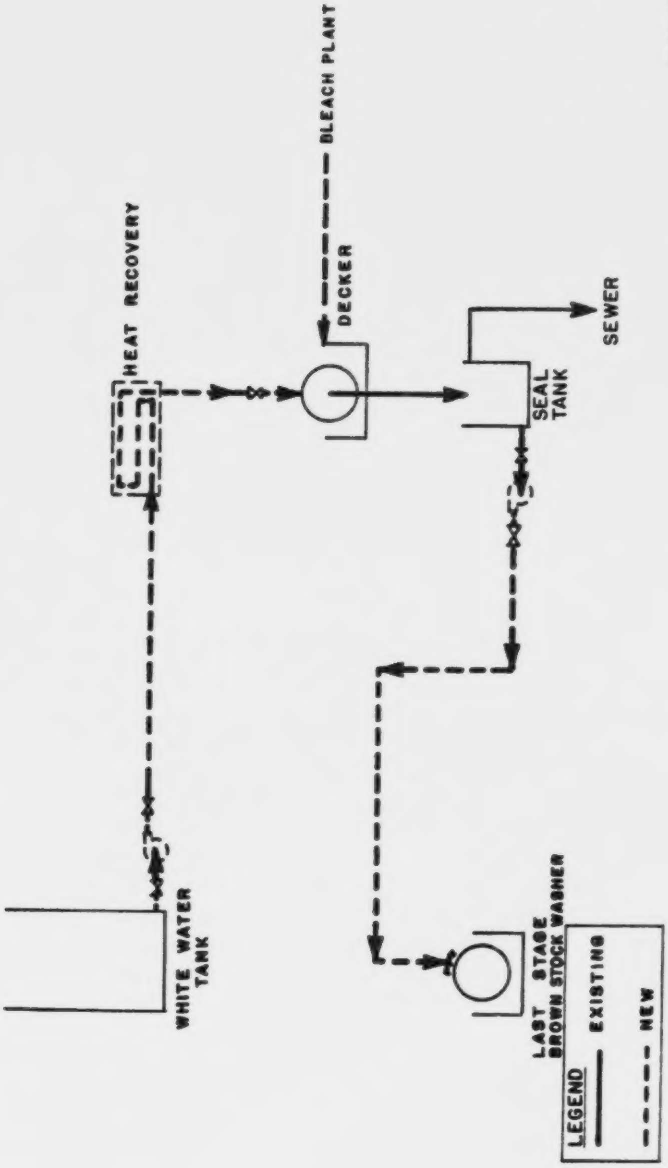

HEAT RECOVERY
BLEACH PLANT
DECKER
SEWER
SEAL TANK
WHITE WATER TANK
LAST STAGE BROWN STOCK WASHER
LEGEND
EXISTING
NEW

FIGURE VII-8
RECYCLE DECKER FILTRATE

with separate discharge to landfill, as shown on Figure VII-9, will reduce TSS raw waste loads.

Typically 2.0 to 3.0 kg/kkg (4.0 to 6.0 lb/t) of TSS would be removed from the raw waste in most of the integrated subcategories. However, this may not affect final effluent characteristics, depending on the existing primary clarifier solids loading. If the clarifier is overloaded, TSS reduction can have an appreciable effect on overall treatment plant performance. If the existing clarifier can readily accommodate this loading, it may be advantageous to continue sewering these wastes. The accompanying fibrous material, when mixed with biological solids, can aid in dewatering of the combined solids. This technology is considered applicable for the tissue from wastepaper subcategory for the purpose of purging dirt from the effluent; this allows for recycle of effluent and recycle of sludge to the furnish. EPA assumed that adequate clarification is already provided at mills in the remaining subcategories.

Bleaching Systems

The extent of bleaching varies widely within the industry. Single stage operations are often used at groundwood and deink mills, while three bleaching stages (i.e., CEH) are common at sulfite and semi-bleached kraft mills. Five or six stages (i.e., CEDED) are often used at fully bleached kraft mills. In multi-stage bleaching, effluents from the first two stages are commonly sewered, although some of the first stage chlorination filtrate may be used to dilute incoming washed brown stock. Bleachery effluent is a major source of process wastewater discharged from integrated bleached kraft and sulfite mills. The following technologies address further steps that may be implemented to reduce effluent flow from multi-stage bleacheries.

Countercurrent or Jump-Stage Washing. This control is applicable at all kraft and soda mills and at many sulfite mills. In jump-stage washing, the filtrate from the second chlorine dioxide washer is used on the showers of the first chlorine dioxide washer; the filtrate from the first chlorine dioxide washer is then used on the showers of the chlorine washer. Filtrate from the second caustic washer is used on the first caustic washer. Jump-stage washing, instead of straight countercurrent washing, is necessary if the first and second caustic washers are constructed of materials that are not sufficiently corrosion resistant (i.e., 304 stainless steel or rubber covered carbon steel rather than the more resistant 317 stainless steel or titanium). Water reduction to levels typical of the discharge from three stage bleacheries may be obtained. Figure VII-10 presents a schematic for jump-stage washing.

In newer mills where all bleach plant washers, pumps, pipelines, repulpers, and other equipment are constructed of 317 stainless steel or equivalent, full countercurrent washing may be implemented. Fresh water or preferably pulp machine or papermachine white water is used for the last stage washer showers and for dilution after high density

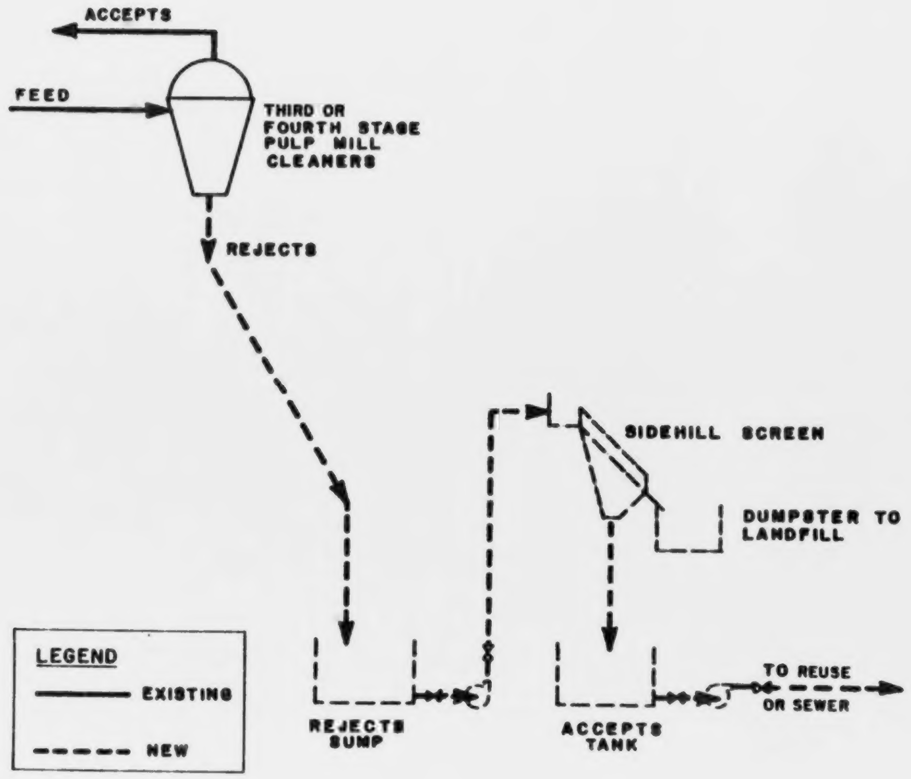

ACCEPTS
FEED
THIRD OR FOURTH STAGE PULP MILL CLEANERS
REJECTS
SIDEHILL SCREEN
DUMPSTER TO LANDFILL
LEGEND
EXISTING
NEW
REJECTS SUMP
ACCEPTS TANK
TO REUSE OR SEWER

FIGURE VII-9
CLEANER REJECTS TO LANDFILL

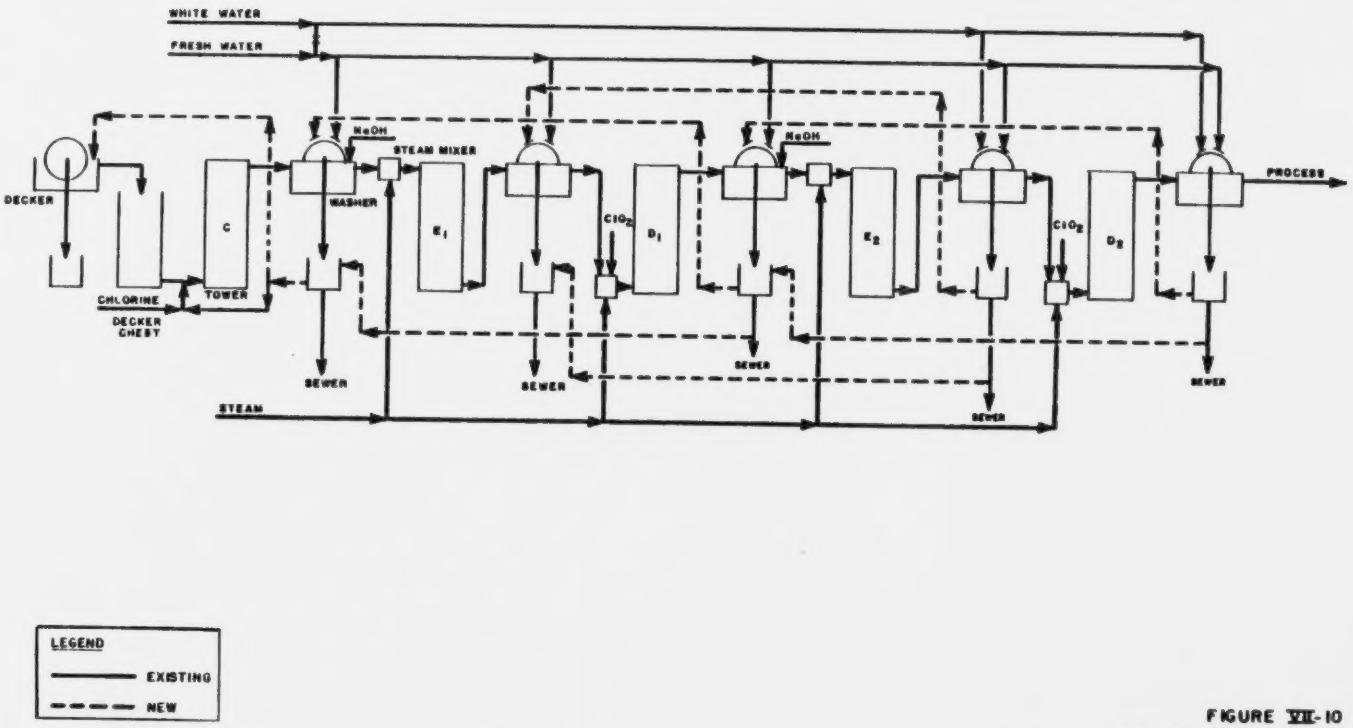

WHITE WATER
FRESH WATER
DECKER
CHLORINE
DECKER CHEST
C
TOWER
NaOH
WASHER
STEAM MIXER
E1
ClO2
D1
NaOH
E2
ClO2
D2
PROCESS
SEWER
SEWER
SEWER
SEWER
SEWER
STEAM
LEGEND
EXISTING
NEW

FIGURE VII-10
JUMP STAGE WASHING IN
BLEACH PLANT

bleached pulp storage. All washer filtrate is used on showers and for dilution of pulp from the preceding stage. Compared to a bleach plant with all fresh water showers, the conversion to full countercurrent washing can reduce bleach plant effluent volume by up to 80 percent. Figure VII-11 presents a schematic for a full countercurrent washing system.

Full countercurrent bleaching using chlorine dioxide necessitates the use of 317 stainless steel or titanium materials of construction for all washers, pumps, and pipelines in the system. If not already in place, such equipment is extremely expensive; by contrast, jump-stage washing sequences can often be readily implemented using existing major equipment with relatively minor alterations, such as the addition of pumps and pipelines to service additional showers.

Earlier studies proposed the use of full countercurrent washing or jump-stage washing in multi-stage kraft and soda pulp mill bleach plants. Jump-stage washing or modifications of such a system are utilized at many mills. Bleach plant water use has declined sharply as a result of these changes. Flow reductions of 8.3 to 25.0 kl/kkg (2.0 to 6.0 kgal/t) are possible through improved countercurrent reuse of filtrates in the bleaching sequence at mills in the alkaline (kraft and soda) and sulfite subcategories. For the simpler papergrade sulfite bleach plants, savings would be about 29.2 kl/kkg (7.0 kgal/t).(53)(61)(62)

Evaporate Caustic Extraction Stage Filtrate. This control is an applicable control technology at mills in the dissolving sulfite pulp subcategory. The hot caustic extraction stage would have a three-stage washing system similar to a red stock washer with carefully controlled hot showers. The effluent from this stage would be evaporated and incinerated or disposed of separately from the rest of the bleachery effluent; therefore, flow would be kept at a minimum. Implementation of this control will greatly reduce the BOD_5 loadings, from 41.4 to 104.4 kg/kkg (82.8 to 208.8 lb/t), depending upon the grade of dissolving sulfite pulp produced.(63) A flow diagram for the bleaching end of this system is shown in Figure VII-12.

Evaporation and Recovery

Production process controls that reduce raw waste loadings in the evaporator and recovery areas include: a) recycle of condensates, b) replacement of the barometric condenser with a surface condenser, c) addition of a boil-out tank, d) neutralization of spent sulfite liquor, e) segregation of cooling water, and f) various spill collection measures. These controls are discussed below.

Recycle of Condensates. Reuse of evaporator condensates was identified as part of the best practicable control technology currently available. (48) The analysis of survey responses indicates that considerable progress has been made in utilizing essentially all condensates. Only in the BCT (paperboard, coarse, and tissue) bleached kraft and the semi-chemical subcategories does extensive

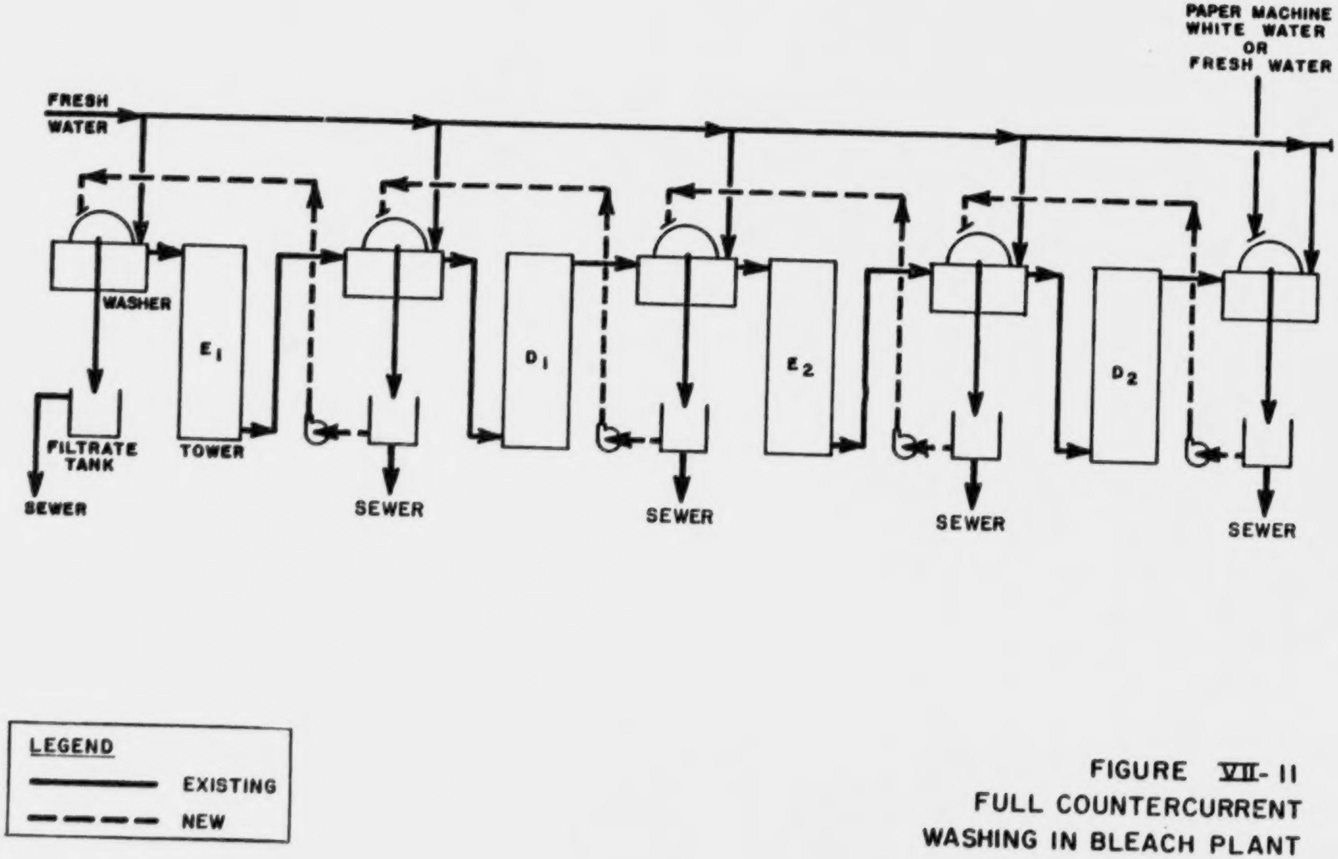

FRESH WATER
PAPER MACHINE WHITE WATER OR FRESH WATER
WASHER
E1
TOWER
FILTRATE TANK
SEWER
D1
E2
D2
SEWER
SEWER
SEWER
SEWER
LEGEND
EXISTING
NEW

FIGURE VII-11
FULL COUNTERCURRENT
WASHING IN BLEACH PLANT

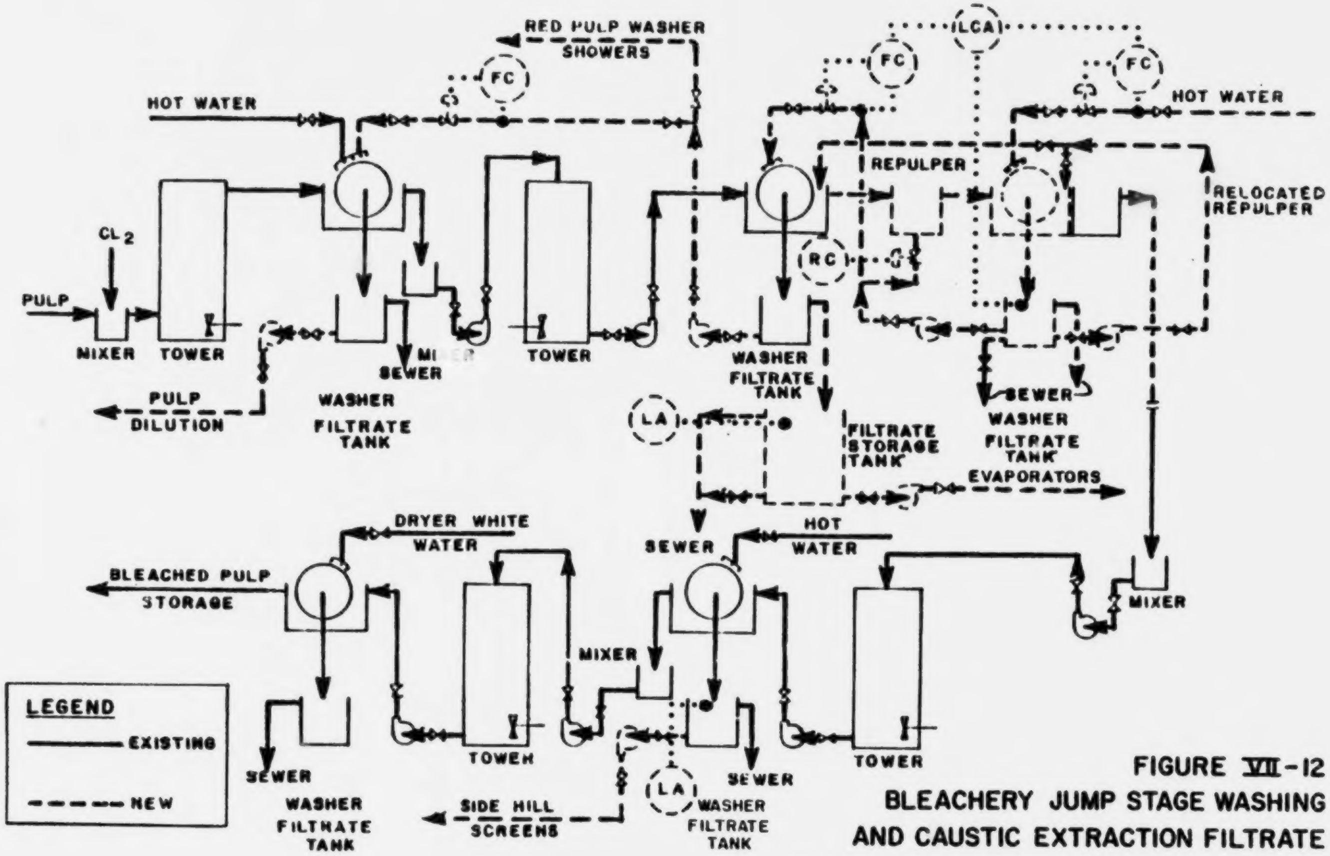

RED PULP WASHER SHOWERS
FC
LCA
FC
FC
HOT WATER
HOT WATER
REPULPER
RELOCATED REPULPER
CL2
PULP
MIXER
TOWER
MIXER
SEWER
TOWER
RC
WASHER FILTRATE TANK
PULP DILUTION
WASHER FILTRATE TANK
SEWER
WASHER FILTRATE TANK
LA
FILTRATE STORAGE TANK
EVAPORATORS
DRYER WHITE WATER
SEWER
HOT WATER
BLEACHED PULP STORAGE
MIXER
MIXER
LEGEND
EXISTING
NEW
SEWER
TOWER
TOWER
SEWER
TOWER
LA
WASHER FILTRATE TANK
SIDE HILL SCREENS
WASHER FILTRATE TANK

FIGURE VII-12
BLEACHERY JUMP STAGE WASHING
AND CAUSTIC EXTRACTION FILTRATE
COLLECTION-DISSOLVING SULFITE PULP

increased recycle of condensate appear feasible when compared to present modes of operation. At BCT bleached kraft mills, improved use of condensate is projected to eliminate up to 7.5 kg/kkg (15.0 lb/t) of BOD_5 from the raw waste. At semi-chemical mills, where lower levels of substrate are dissolved, the reuse of condensate represents a far lower BOD_5 saving, generally less than 0.25 kg/kkg (0.50 lb/t). A flow schematic for this system is shown in Figure VII-13.

Replace Barometric Condenser. At most mills in all integrated subcategories, except for dissolving kraft, surface condensers are used. Similarly, in the dissolving kraft subcategory, barometric condensers can be replaced with surface condensers, thus assuring a clean, warm condenser water stream that can be reused. This also results in a smaller concentrated stream of condensate that may be reused in the causticizing area or in the brown stock washer area or that can be steam stripped and reused for other purposes. Existing barometric condenser seal tanks could be reused as the seal tanks for new surface condensers. The air ejectors would be retained as stand-by, for use during system start-up. A cooling water pump would be provided to pump mill process water through the condenser and return it to the process water main.

In summer, the cooling water may be too hot to return entirely to process. Automatic temperature control could be implemented to divert excess water to a non-contact water thermal sewer and return only an acceptable amount to the process water line. A new condensate pump could be provided to pump to the required discharge point or to washers where the condensate could be reused. This production process control is illustrated in Figure VII-14. Implementation of this technology would result in less than a 0.5 kg/kkg (1.0 lb/t) BOD_5 reduction and less than a 4.2 kl/kkg (1.0 kgal/t) flow reduction.(53)(64) This technology is applicable at new mills.

Addition of a Boilout Tank. This control is applicable at mills in the dissolving kraft and market bleached kraft subcategories. Water for the boilout would be pumped to the evaporators from the boilout tank, which would be full at the start of the process. When the concentration of the black liquor from the evaporators starts to decrease, the flow could be diverted to the weak black liquor tank. When the concentration decreases further to a predetermined value, the flow could be diverted to the boilout tank. Overflow from the condensate tank, which occurs during boilout because of an increased rate of evaporation, could also be diverted to the boilout tank. After the boilout is complete and weak black liquor is again fed to the evaporator, weak black liquor flow would be initially diverted to the weak black liquor tank and eventually to the strong black liquor tank. This system is shown in Figure VII-15.

Neutralize Spent Sulfite Liquor. In both the dissolving sulfite pulp and both papergrade sulfite subcategories (particularly at mills with MgO systems), neutralization of spent sulfite liquor before evaporation will reduce raw waste loadings of BOD_5. Neutralization gives a significant reduction in the carry-over of organic compounds

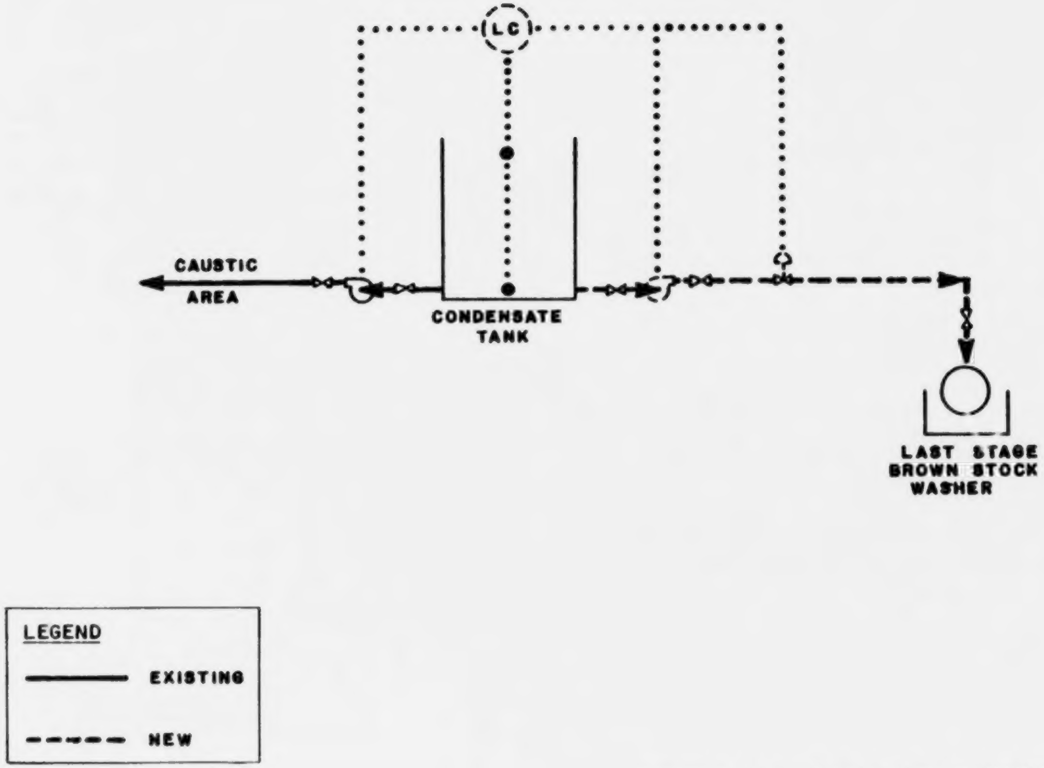

LC
CAUSTIC
AREA
CONDENSATE
TANK
LAST STAGE
BROWN STOCK
WASHER
LEGEND
EXISTING
NEW

FIGURE VII - 13

COMPLETE REUSE OF EVAPORATOR CONDENSATE
KRAFT AND SODA MILLS

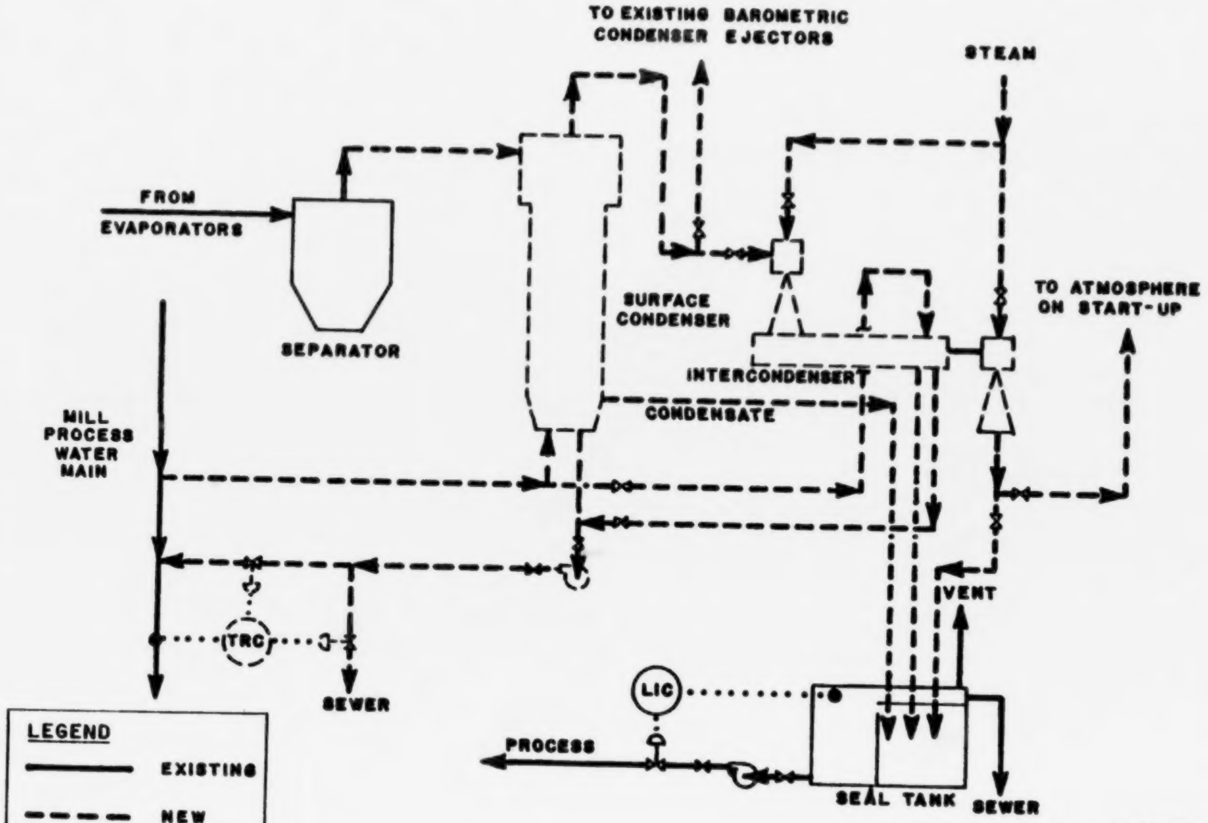

TO EXISTING BAROMETRIC CONDENSER EJECTORS
STEAM
FROM EVAPORATORS
SEPARATOR
SURFACE CONDENSER
TO ATMOSPHERE ON START-UP
INTERCONDENSER
CONDENSATE
MILL PROCESS WATER MAIN
VENT
TRC
LIC
SEWER
PROCESS
SEAL TANK
SEWER
LEGEND
EXISTING
NEW

FIGURE VII- 14
REPLACE BAROMETRIC CONDENSER
WITH SURFACE CONDENSER

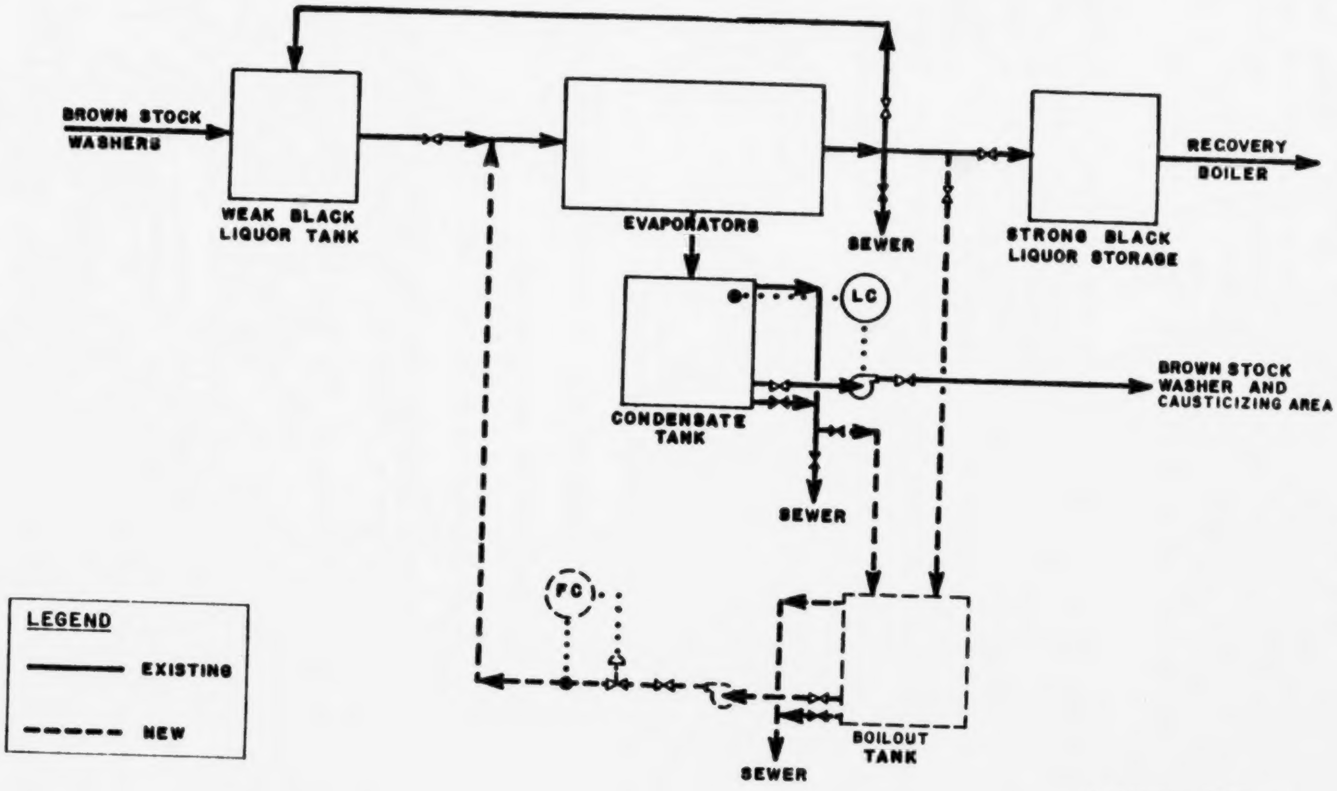

BROWN STOCK WASHERS
WEAK BLACK LIQUOR TANK
EVAPORATORS
SEWER
STRONG BLACK LIQUOR STORAGE
RECOVERY BOILER
LC
CONDENSATE TANK
BROWN STOCK WASHER AND CAUSTICIZING AREA
SEWER
FC
BOILOUT TANK
SEWER
LEGEND
EXISTING
NEW

FIGURE VII- 15
ADDITION OF AN EVAPORATOR BOILOUT TANK

to the condensate. Depending on the mode of operation, this reduction can range from 1.0 to 1.5 kg/kkg (2.0 to 3.0 lb/t) of BOD5 at papergrade sulfite mills and up to 25.0 kg/kkg (50.0 lb/t) of BOD5 at dissolving sulfite mills. Figure VII-16 shows the modifications. At sulfite mills where a MgO or a sodium base is not used, an organics removal system could be used to enable recycle of evaporator condensate. The reduction in BOD5 load is of the same order of magnitude as with spent sulfite liquor neutralization, but could involve a greater capital cost. Organics removal is essential to prevent build-up in the system when extensive condensate recycle is practiced. At most mills where this technology is applicable, this control strategy has been implemented. It is also applicable for use at new mills.

Segregation of Cooling Water. Segregation and reuse of cooling water in the evaporator and recovery area of semi-chemical mills can result in substantial flow reductions. Estimated flow reductions of approximately 1.7 kl/kkg (0.4 kgal/t) result.(53)(54) At some of these mills, extensive reuse of cooling water is practiced; however, smaller streams are typically discharged to the sewer. Elimination of the discharge of these sewered streams would reduce the flow to the treatment facility. The equipment requirements are similar to those shown earlier in Figure VII-3 for application in the woodroom area.

Spill Collection. Spill collection in the evaporator, recovery, causticizing, and liquor storage areas could be implemented to varying degrees at mills in three kraft subcategories. The spill collection system applicable at mills in each subcategory varies widely, depending on the existing level of implementation. This technology involves the use of the following techniques, all of which are being used at some mills in certain subcategories:

o spill collection in the evaporator and recovery boiler area,

o spill collection in the liquor storage area,

o spill collection in the causticizing area, and

o addition of a spare liquor tank to accept spills from any of these three areas and a pump to return a spill to its point of origin.

All spill collection systems involve the use of a sump and a pump to divert the spill to the spill tank. If the tank were full, spills could be diverted to a spill lagoon. The spill collection sump for the liquor storage area could be equipped with a conductivity controller which allows surface run-off and low conductivity spills to be diverted to the spill lagoon, while allowing high conductivity spills to be sent to the spill tank for recovery. A flow diagram for a typical system is shown in Figure VII-17.(57)(65)(66)

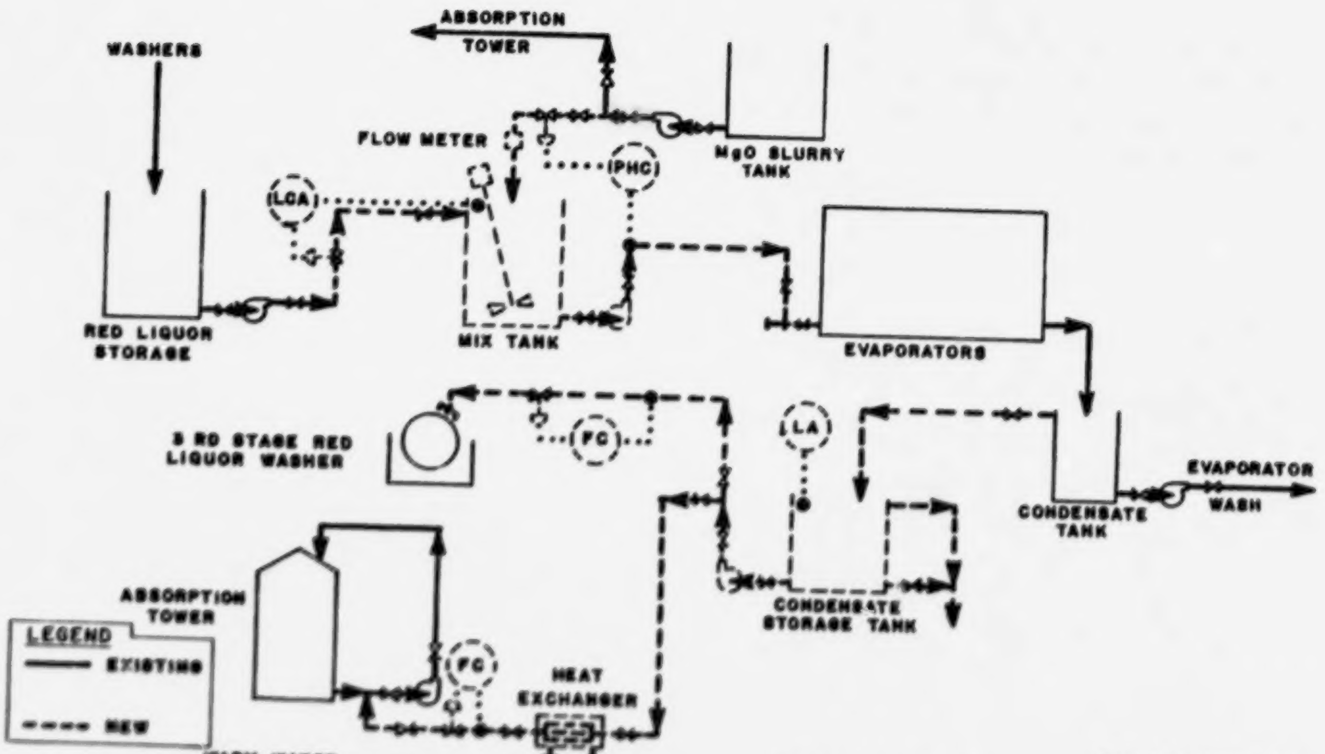

WASHERS
ABSORPTION TOWER
FLOW METER
LCA
PHC
MgO SLURRY TANK
RED LIQUOR STORAGE
MIX TANK
EVAPORATORS
3 RD STAGE RED LIQUOR WASHER
FC
LA
CONDENSATE TANK
EVAPORATOR WASH
CONDENSATE STORAGE TANK
ABSORPTION TOWER
LEGEND
EXISTING
NEW
FC
HEAT EXCHANGER
WARM WATER HEADER
FRESH WATER HEADER

FIGURE VII- 16
NEUTRALIZATION OF
SPENT SULFITE LIQUOR

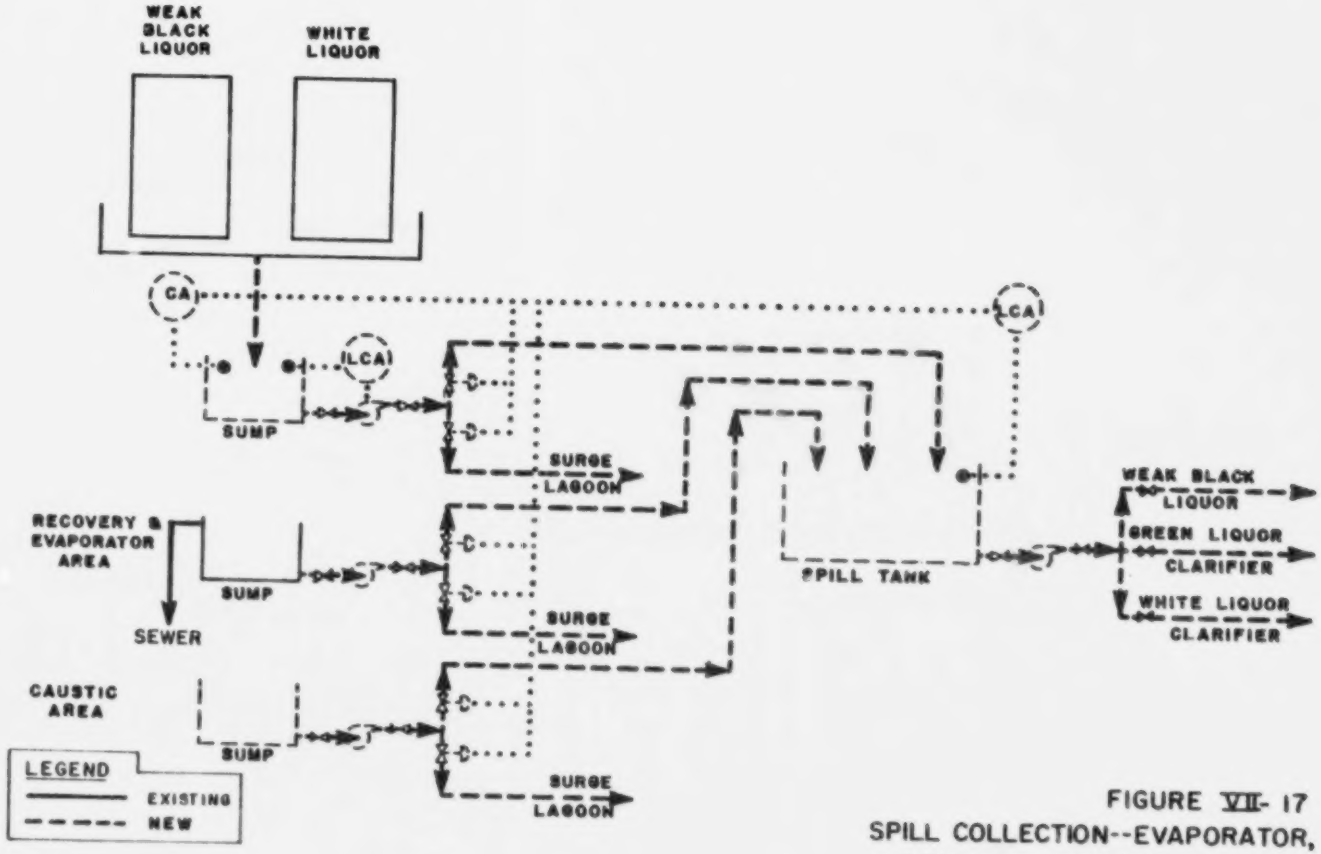

WEAK BLACK LIQUOR
WHITE LIQUOR
CA
LCA
SUMP
LCA
SURGE LAGOON
RECOVERY & EVAPORATOR AREA
SUMP
SEWER
SURGE LAGOON
CAUSTIC AREA
SUMP
SURGE LAGOON
SPILL TANK
WEAK BLACK LIQUOR
GREEN LIQUOR CLARIFIER
WHITE LIQUOR CLARIFIER
LEGEND
EXISTING
NEW

FIGURE VII- 17
SPILL COLLECTION--EVAPORATOR, RECOVERY, CAUSTICIZING AND LIQUOR STORAGE AREAS

Liquor Preparation Area

Production process controls that reduce raw waste loads in the liquor preparation area include installation of a green liquor dregs filter and lime mud pond, as described below.

Installation of Green Liquor Dregs Filter. At an alkaline (kraft or soda) pulp mill with a modern recovery furnace, green liquor dregs contribute approximately 5.0 kg/kkg (10.0 lb/t) of TSS.(28) Diversion of this material from the primary clarifier can have a beneficial effect. The dregs are usually pumped from a gravity-type dregs washer or clarifier at very low consistencies with accompanying high strength alkaline liquor entrainment. This may have an appreciable effect on pH at the clarifier. In addition, the material tends to be of a fine colloidal nature and can be difficult to settle.

At many modern mills, belt-type filters have been installed to improve washing and sodium recovery from the dregs. This results in a drier material that can readily be disposed of at a landfill site. For mills having only a gravity type unit, a small vacuum filter can be employed. Condensate can be applied for washing the cake on the filter with subsequent use of the filtrate in the dregs washer itself. This creates a countercurrent system that is effective in the recovery of sodium and for dry dregs disposal. Generally, such projects are justified on the basis of alkali saving. This decision depends on the capability of the existing primary clarifier and sludge thickening operations. Figure VII-18 presents a schematic of this control technology. Such devices are generally applicable at all mills in the alkaline (kraft and soda) subcategories. However, if adequate primary clarification is provided, this technology may result in little improvement in overall treatment system performance.

Installation of a Lime Mud Pond. At kraft pulp mills, the use of a lime mud pond can reduce TSS discharges caused by upsets, start-ups, and shutdowns in the white liquor clarification and mud washing area.

A spill collection diversion system, incorporating a pond for liquors containing high quantities of lime mud, allows for reuse of this mud. It also assures minimum upsets at the primary clarifier in the case of a dump of a unit containing high concentrations of lime. Such a dump could occur during a period of outage or repair. Figure VII-19 presents a schematic of this control technology. Typical long-term savings average 1.5 to 2.5 kg/kkg (3.0 to 5.0 lb/t) of TSS in kraft pulp mills.(58) However, this control technology may result in little improvement in overall treatment system performance at facilities with adequate primary clarification. It may, however, be justified at many mills on the basis of the resulting savings in lime cost.

Papermill

Production process controls that reduce raw waste loading in the papermill area include: a) papermachine, bleached pulp (furnish), and color plant spill collection, b) saveall improvements, c)

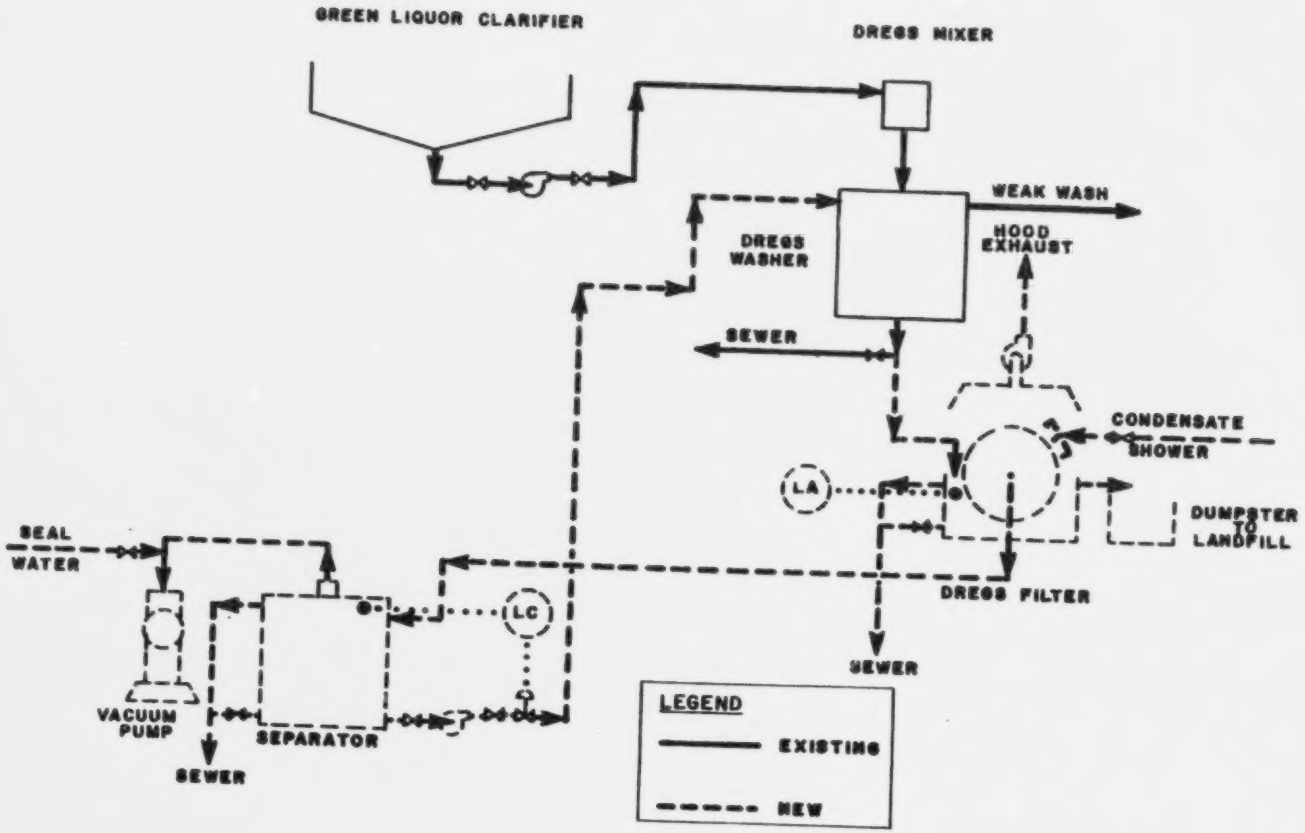

GREEN LIQUOR CLARIFIER
DREGS MIXER
WEAK WASH
HOOD EXHAUST
DREGS WASHER
SEWER
CONDENSATE SHOWER
LA
DUMPSTER TO LANDFILL
DREGS FILTER
SEWER
SEAL WATER
LC
VACUUM PUMP
SEPARATOR
SEWER
LEGEND
EXISTING
NEW

FIGURE VII- 18
GREEN LIQUOR DREGS FILTER

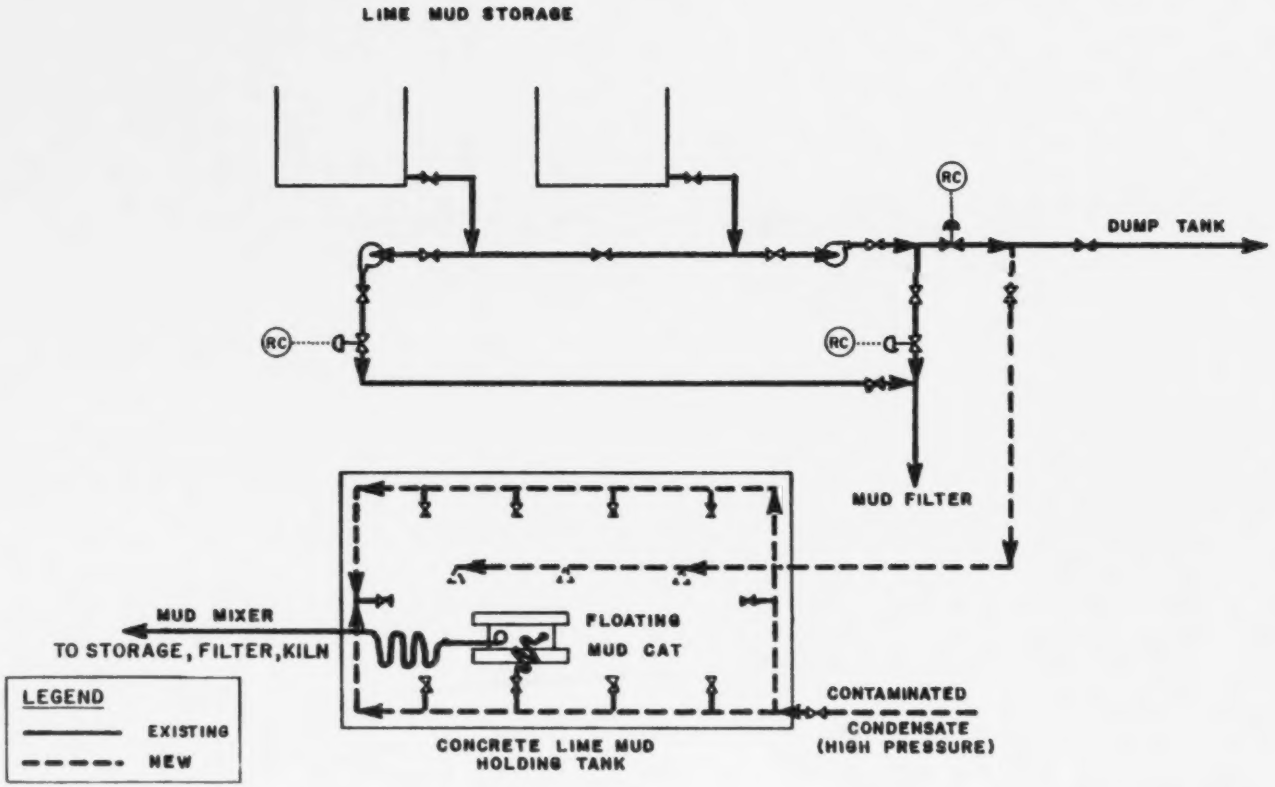

LIME MUD STORAGE
RC
RC
RC
DUMP TANK
MUD FILTER
FLOATING
MUD CAT
MUD MIXER
TO STORAGE, FILTER, KILN
CONTAMINATED
CONDENSATE
(HIGH PRESSURE)
CONCRETE LIME MUD
HOLDING TANK
LEGEND
EXISTING
NEW

FIGURE VII- 19
LIME MUD STORAGE POND

high-pressure showers for wire and felt cleaning, d) white water use for vacuum pump sealing, e) white water showers for wire cleaning, f) white water storage for upsets and pulper dilution, g) recycle of press effluent, h) reuse of vacuum pump water, i) provision for additional broke storage, j) installation of wet lap machines, k) segregation of cooling water, l) collection of cleaner rejects for landfill disposal, and m) addition of fourth stage cleaners. These specific controls, their applicability to the various subcategories, and their general effectiveness are described individually in the following paragraphs.

Spill Collection. Papermachine and bleached pulp (furnish) storage area spill collection is applicable at mills in all of the bleached kraft and soda, sulfite, groundwood, and nonintegrated subcategories. The extent of application of this control varies by subcategory, depending on factors such as the number of machines and the extent to which spill collection already exists at the various mills. For the bleached kraft, soda, and sulfite subcategories, spill collection systems could be installed to handle overflows and equipment drains along with spills from the bleached stock storage area, the stock preparation areas, and the papermachine or pulp machine wet ends. As shown in Figures VII-20 through VII-22, these systems would generally require installation of a new sump, a new stock tank, and a pump to return the spills to a point where they could be blended back into the process. This control can result in substantial stock savings and a reduction in TSS load. Savings estimates vary widely, but may typically be 2.0 to 2.5 kg/kkg (4.0 to 5.0 lb/t) of TSS and 0.6 to 0.8 kg/kkg (1.2 to 1.6 lb/t) of BOD_5.

Collection of color plant spills can be implemented at mills in all subcategories where fine coated papers are manufactured. One spill collection system could be applied for each machine which has a coater or size press. With this system, spills and wash water would be collected in a sump and stored for reuse. The system provides for control of spills in all the storage and mix tank areas of the color plant and at the coater, tanks, and screens. Implementation of this control would result in savings of expensive coating pigments and adhesives as well as a reduction in the TSS load. A flow diagram is shown in Figure VII-23.

Improvement of Savealls. The use of savealls was identified as part of the best practicable control technology currently available. At most mills, savealls have been employed. The present emphasis on savealls is to improve their performance. Mills in many subcategories could benefit from saveall improvements such as the installation of new vacuum disc savealls or the reworking of existing savealls by adding some new equipment. Savealls can be employed on all types of machines producing all types of products including fine papers, board, tissue papers, molded products, and newsprint. Most of the savealls being installed today are of the vacuum disc filter type. They are flexible in handling various types of stock and shock loadings and exhibit high separation efficiencies. As a control item, their use results in flow and solids reductions. Nearly all stock saved is

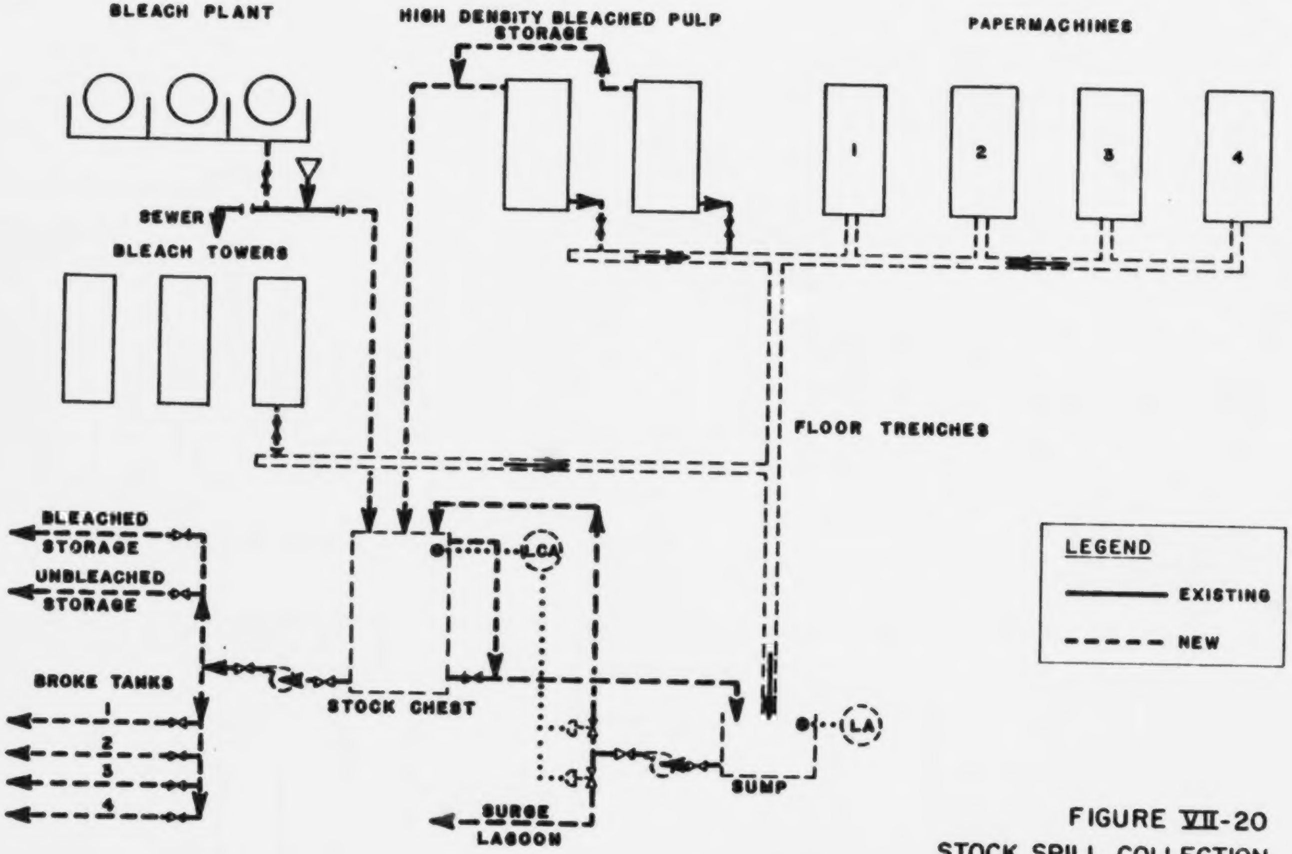

BLEACH PLANT
HIGH DENSITY BLEACHED PULP STORAGE
PAPERMACHINES
1
2
3
4
SEWER
BLEACH TOWERS
FLOOR TRENCHES
LCA
BLEACHED STORAGE
UNBLEACHED STORAGE
BROKE TANKS
1
2
3
4
STOCK CHEST
SUMP
LA
SURGE LAGOON
LEGEND
EXISTING
NEW

FIGURE VII-20
STOCK SPILL COLLECTION
PULP BLEACHING & PAPERMACHINE AREAS
PAPERGRADE SULFITE

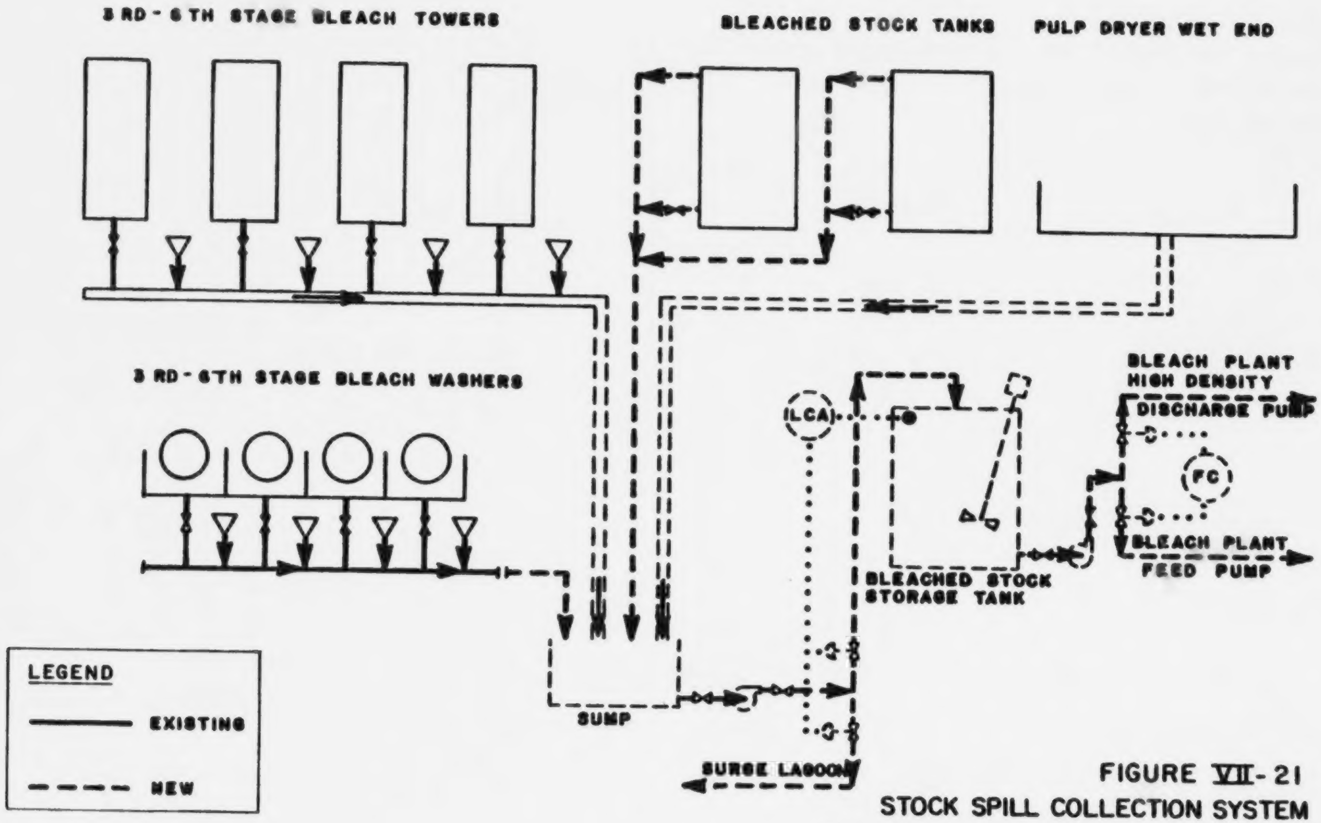

3 RD - 6 TH STAGE BLEACH TOWERS
BLEACHED STOCK TANKS
PULP DRYER WET END
3 RD - 6 TH STAGE BLEACH WASHERS
BLEACH PLANT HIGH DENSITY DISCHARGE PUMP
LCA
FC
BLEACH PLANT FEED PUMP
BLEACHED STOCK STORAGE TANK
SUMP
SURGE LAGOON
LEGEND
EXISTING
NEW

FIGURE VII-21
STOCK SPILL COLLECTION SYSTEM
PULP BLEACHING AND DRYER AREAS
BLEACHED KRAFT AND SODA MILLS

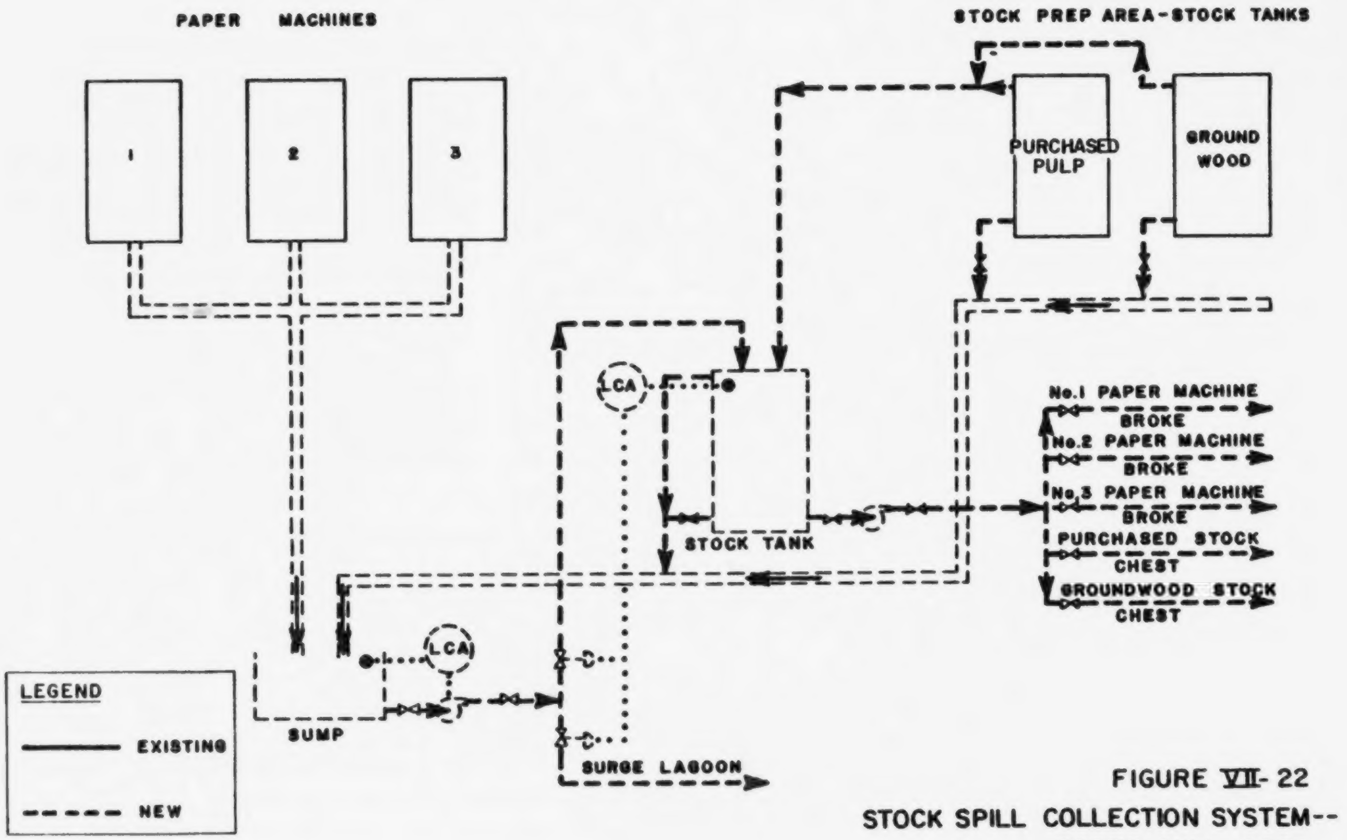

PAPER MACHINES
1
2
3
STOCK PREP AREA-STOCK TANKS
PURCHASED PULP
GROUND WOOD
LCA
STOCK TANK
No.1 PAPER MACHINE BROKE
No.2 PAPER MACHINE BROKE
No.3 PAPER MACHINE BROKE
PURCHASED STOCK CHEST
GROUNDWOOD STOCK CHEST
LCA
SUMP
SURGE LAGOON
LEGEND
EXISTING
NEW

FIGURE VII- 22
STOCK SPILL COLLECTION SYSTEM--
PAPER MILL AREA
GROUNDWOOD - CMN OR FINE PAPERS

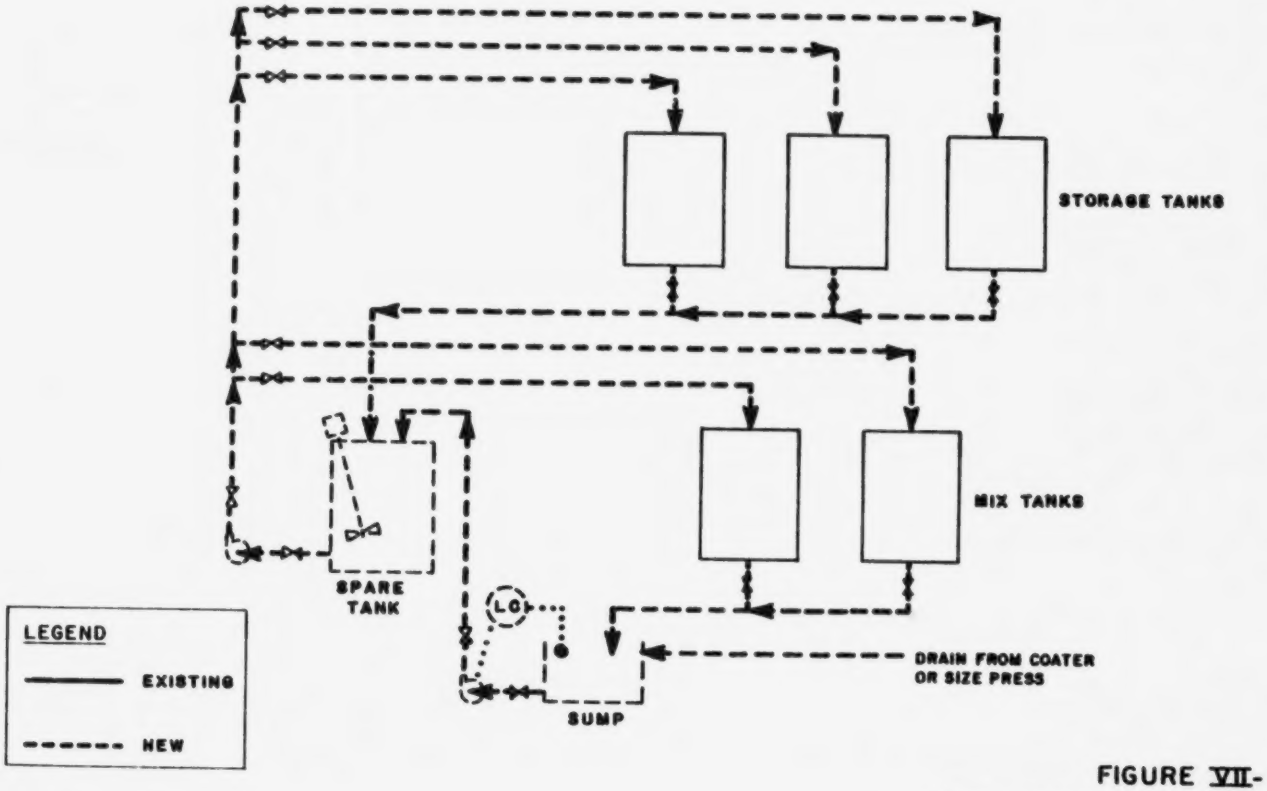

STORAGE TANKS
MIX TANKS
SPARE TANK
LC
SUMP
DRAIN FROM COATER OR SIZE PRESS
LEGEND
EXISTING
NEW

FIGURE VII- 23
SPILL COLLECTION SYSTEM
COLOR PLANT--ALKALINE-FINE[1]

---

[1] INCLUDES FINE BLEACHED KRAFT AND SODA SUBCATEGORIES

stored or reused immediately. The clear white water can be readily reused within the mill, replacing some fresh water uses. If not reused, it becomes a relatively clear overflow to the sewer. Significant flow reductions can be attained when an effective saveall is used in that extensive filtrate recycle becomes possible.

At mills with existing savealls, entire installations are not likely to be required. In these cases, a new saveall could replace the existing saveall on the largest machine, making use of existing pumps, tanks, and piping. The existing saveall could be repiped for the next smaller machine, and so on down the line, so that each machine may have a larger, more effective saveall. Figures VII-24 through VII-26 illustrate typical saveall installations. The resulting overall white water balance determines the net savings, but flow reductions of from about 0.8 to 41.7 kl/kkg (0.2 to 10.0 kgal/t) are possible depending on the type of mill and level of white water reuse.(60)

Use of High Pressure Showers for Wire and Felt Cleaning. High pressure showers to replace low pressure, high volume showers (i.e., those used for felt cleaning, return wire cleaning, and couch roll cleaning) may save up to 90 percent of the water used in conventional shower applications and may be more effective. It is generally considered that felt cleaning showers are operated at 35.2 kg/sq cm (500 psi) and Fourdrinier showers at 21.1 kg/sq cm (300 psi). A typical installation is shown in Figure VII-24. High pressure showers are applicable at mills in the dissolving kraft, dissolving sulfite pulp, deink, nonintegrated-fine papers, nonintegrated-filter and nonwoven papers, and nonintegrated-lightweight papers subcategories. Application is, however, generally universal in the industry.(60)(67)(68)(69)(70)

White Water Use for Vacuum Pump Sealing. Excess clarified white water has been successfully used to replace fresh water on mill vacuum pumps. The vacuum pump seal water may then be recycled or discharged. At a minimum, the equivalent quantity of fresh water use is directly displaced. Corrosion and abrasion may be deterrents to implementation of this system, particularly at low pH or high filler levels. As shown in Figure VII-27, fresh water addition may be required and can be provided to maintain temperatures below 32°C (90°F). This technology can be applied at mills in all subcategories. Resulting reductions in waste loadings depend on the overall water balance, but flows of 94.6 to 380 liters/minute (25 to 100 gpm) per pump are common.(67)(68)(69)(71)(72)

Papermachine White Water Use on Wire Cleaning Showers. Clarified white water from the papermachine saveall, containing low levels of additives and fillers, can be used on wire cleaning showers. White water can be used on Fourdrinier showers and knock-off showers as shown earlier in Figures VII-24 through VII-26. The system includes a white water supply pump, supply piping, and showers. A fresh water backup supply header is provided with controls for introduction of fresh water to the white water chest in the event of low volume in the

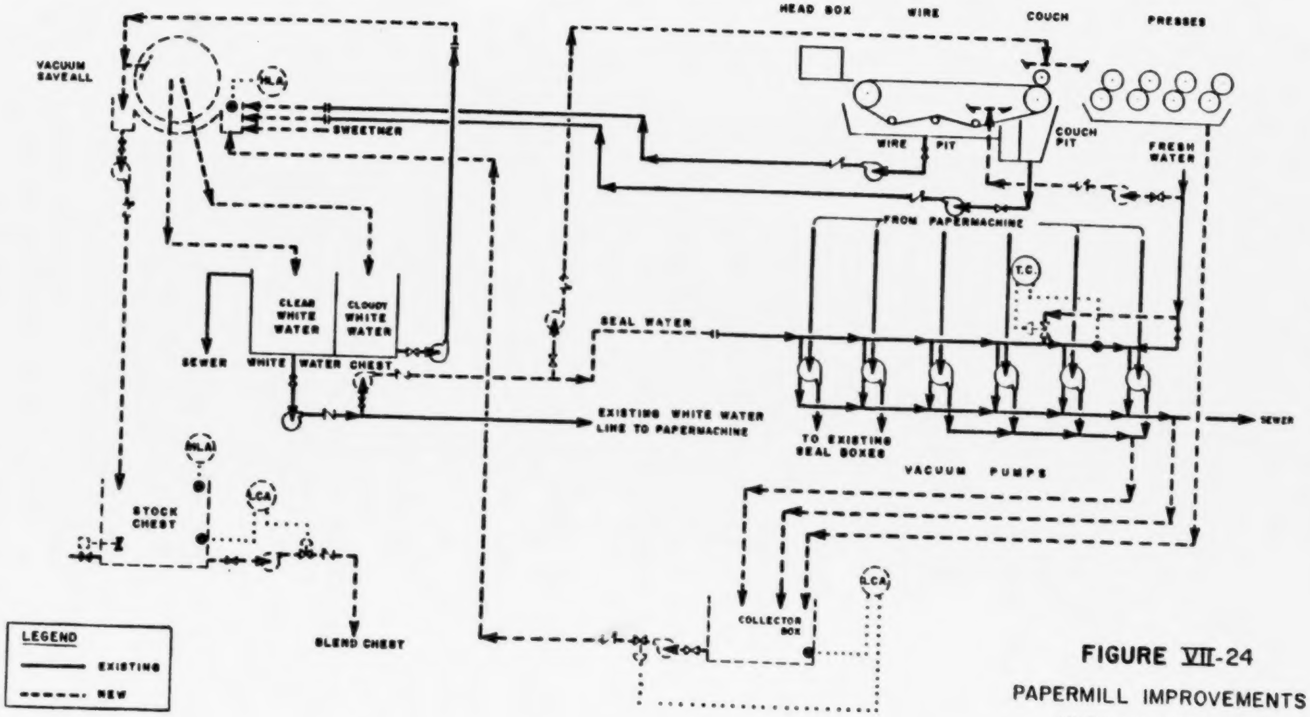

HEAD BOX
WIRE
COUCH
PRESSES
VACUUM SAVEALL
H.L.A.
SWEETNER
WIRE PIT
COUCH PIT
FRESH WATER
FROM PAPERMACHINE
T.C.
CLEAR WHITE WATER
CLOUDY WHITE WATER
SEWER
WHITE WATER CHEST
SEAL WATER
EXISTING WHITE WATER LINE TO PAPERMACHINE
TO EXISTING SEAL BOXES
VACUUM PUMPS
SEWER
H.L.A.
L.C.A.
STOCK CHEST
BLEND CHEST
COLLECTOR BOX
L.C.A.
LEGEND
EXISTING
NEW

FIGURE VII-24

PAPERMILL IMPROVEMENTS – UNBLEACHED KRAFT

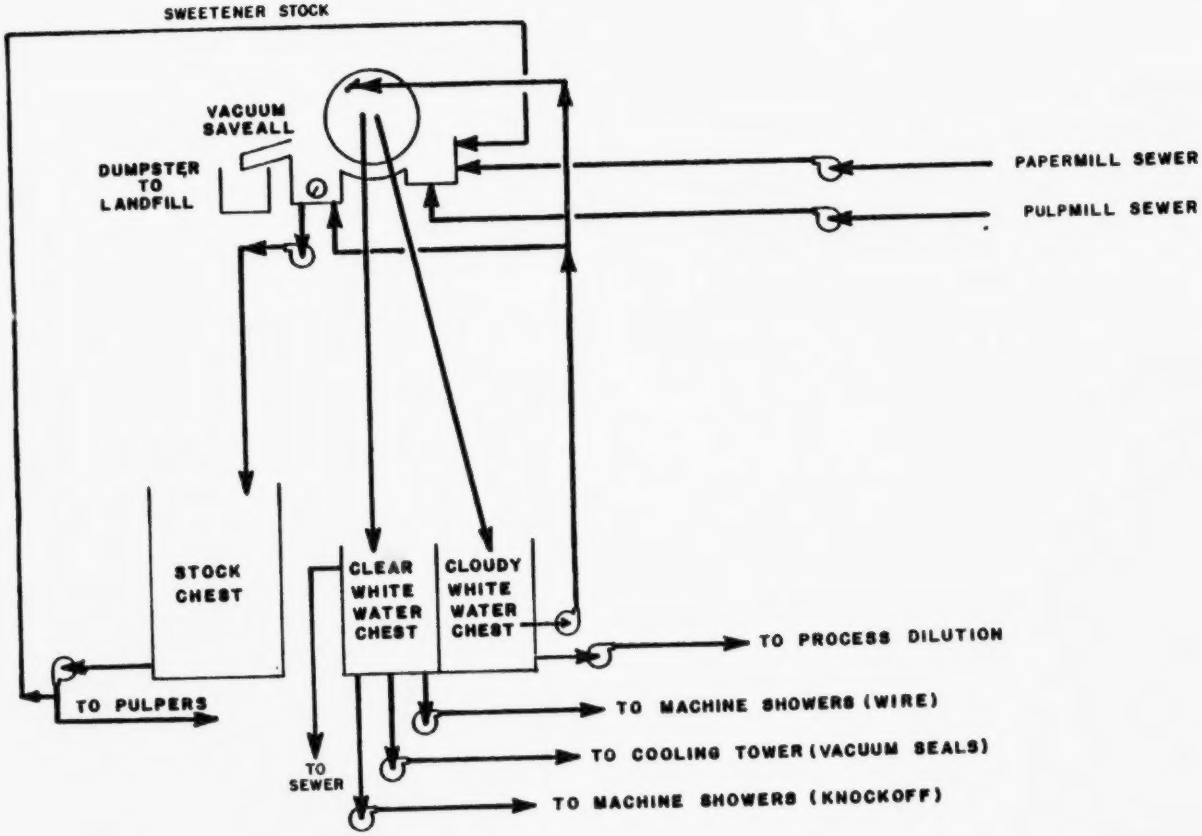

SWEETENER STOCK
VACUUM SAVEALL
DUMPSTER TO LANDFILL
PAPERMILL SEWER
PULPMILL SEWER
STOCK CHEST
CLEAR WHITE WATER CHEST
CLOUDY WHITE WATER CHEST
TO PROCESS DILUTION
TO PULPERS
TO MACHINE SHOWERS (WIRE)
TO COOLING TOWER (VACUUM SEALS)
TO SEWER
TO MACHINE SHOWERS (KNOCKOFF)

FIGURE VII - 25

NEW SAVEALL ON PULP & PAPERMILL EFFLUENTS --
BUILDERS' PAPER & ROOFING FELT

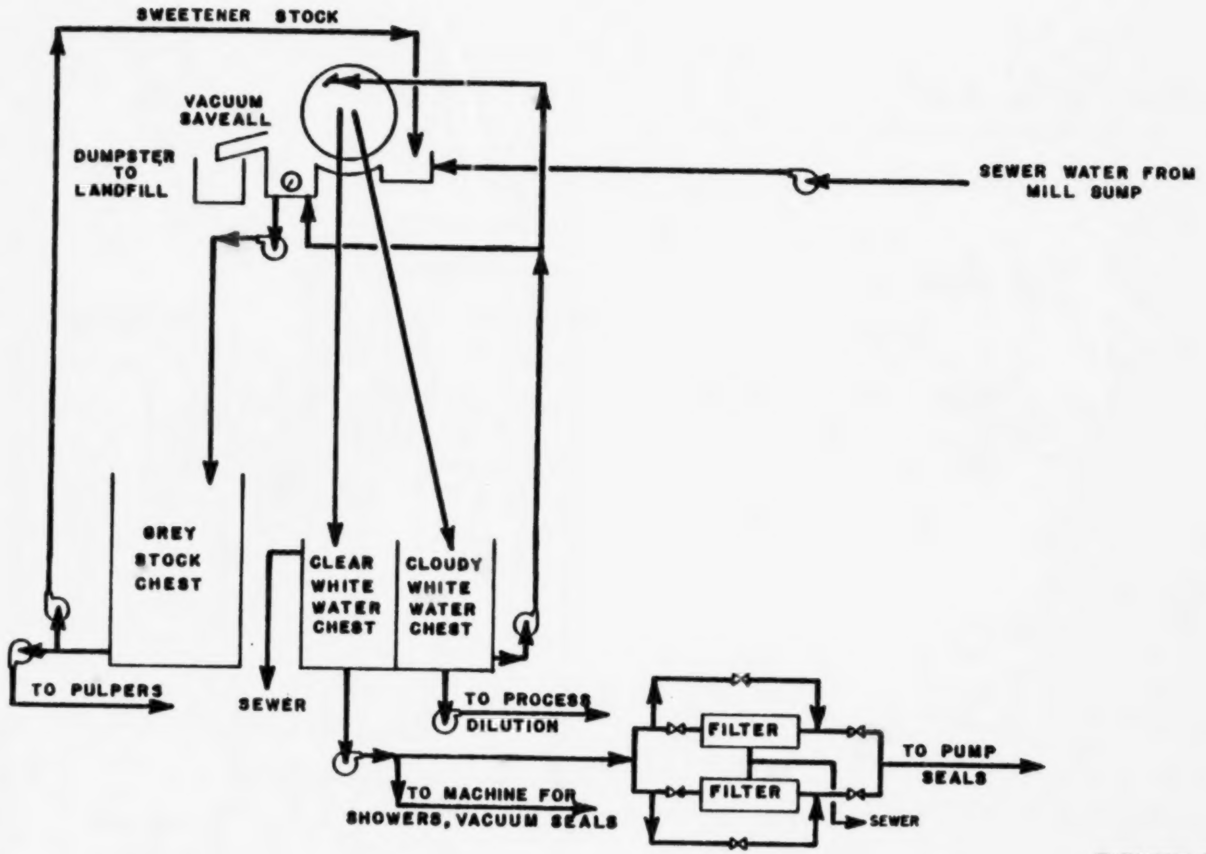

SWEETENER STOCK
VACUUM SAVEALL
DUMPSTER TO LANDFILL
SEWER WATER FROM MILL SUMP
GREY STOCK CHEST
CLEAR WHITE WATER CHEST
CLOUDY WHITE WATER CHEST
TO PULPERS
SEWER
TO PROCESS DILUTION
TO MACHINE FOR SHOWERS, VACUUM SEALS
FILTER
FILTER
TO PUMP SEALS
SEWER

FIGURE VII - 26
NEW SAVEALL ON PAPERMILL
EFFLUENT - WASTEPAPER - MOLDED PRODUCTS

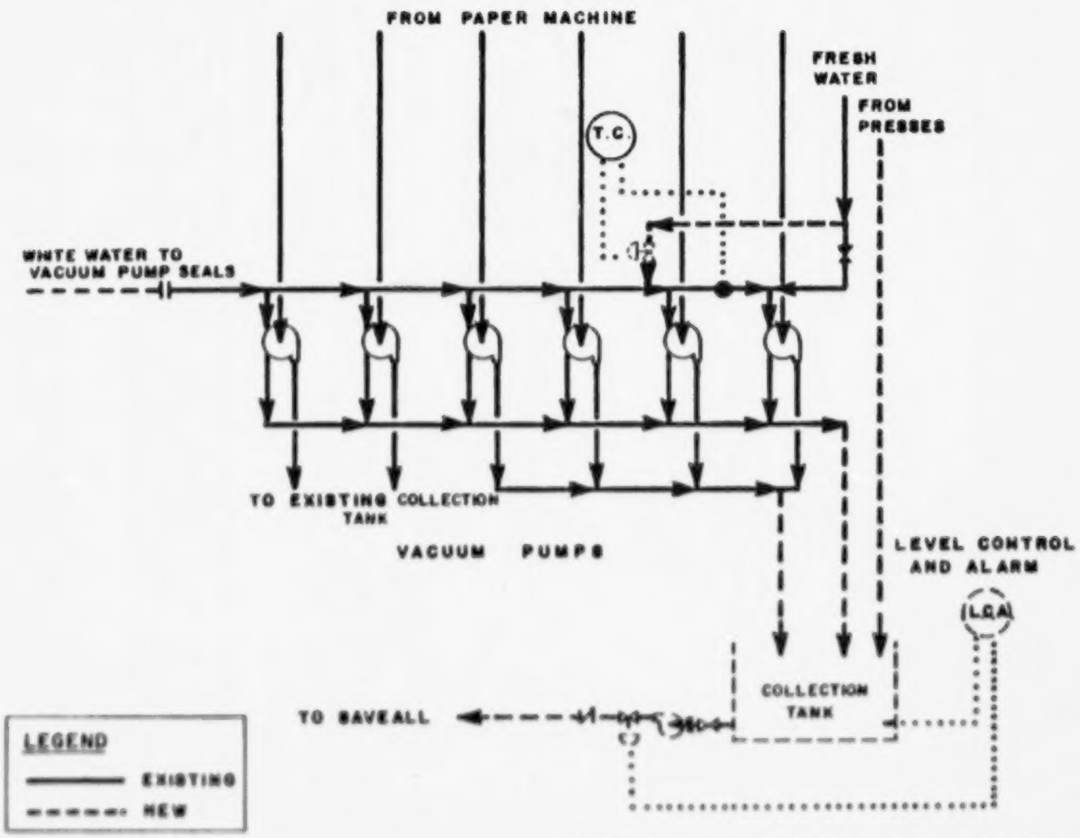

FROM PAPER MACHINE
FRESH WATER
FROM PRESSES
T.C.
WHITE WATER TO VACUUM PUMP SEALS
TO EXISTING COLLECTION TANK
VACUUM PUMPS
LEVEL CONTROL AND ALARM
LCA
COLLECTION TANK
TO SAVEALL
LEGEND
EXISTING
NEW

FIGURE VII-27
WHITE WATER TO VACUUM PUMPS AND COLLECTION TANK
FOR PUMP SEAL WATER AND PRESS EFFLUENT

chest. The effect of implementation of this control varies widely by machine and type of mill.

White Water Storage for Upsets and Pulper Dilution. As illustrated in Figure VII-28, this system consists of an additional storage tank to store excess white water that would overflow from the existing clear white water tank. Where possible, the tank could be adjacent to or added onto the existing tank to eliminate pumping costs.

The white water from this tank can be used in the pulper or bleach plant. The tank would be sized to hold adequate white water needed for pulp dilution after pulping, bleach plant washing, or continuous washing requirements. A fresh water header is provided to the tank for makeup.

A separate system may be needed for each machine, depending on the variability of furnish. Each machine may have its own pulper and require a completely separate white water system. Increased storage facilities can provide significant flow reductions; BOD_5 and TSS reductions may also result.(60)

Recycle of Press Water. Effluent from the press section of a papermachine contains fibrous fines and fillers that can be reintroduced into the white water system and recovered. Water from the vacuum presses, as well as pressure rolls, can be piped to a collection tank (or wire pit) often without the need for pumping. From the tank, the water can be pumped to the saveall system to reclaim the fiber and fillers and to make the water available for use in the white water systems. This would reduce solids and may reduce flow to the wastewater treatment plant. Generally, a separate system would be required for each machine.

Felt hairs, previously a deterrent in some systems, have been largely eliminated with the advent of synthetic felts. Thus, provision for the removal of felt hairs has not been contemplated in the system, although such provision may be required on top-of-the-line printing or specialty grades, at least during periods of use of new felts.

Reuse of Vacuum Pump Water. Recycle of vacuum pump water (most of which is seal water) and/or use of white water as seal water (Figure VII-27) will nearly eliminate fresh water additions for these uses. Installation of the system would require piping, a collection tank, and a pump to return the water to storage for reuse. One system is needed for each machine.

At many mills, specific collection systems are not employed for press effluent and vacuum pump seal water. By combining the two systems, cost reductions could be realized. Up to 21.0 kl/kkg (5.0 kgal/t) may be saved.(49) Typically, flow reductions are estimated at less than 8.3 kl/kkg (2.0 kgal/t).

Additional Broke Storage. An additional broke storage chest could be installed at most mills in the nonintegrated-lightweight papers

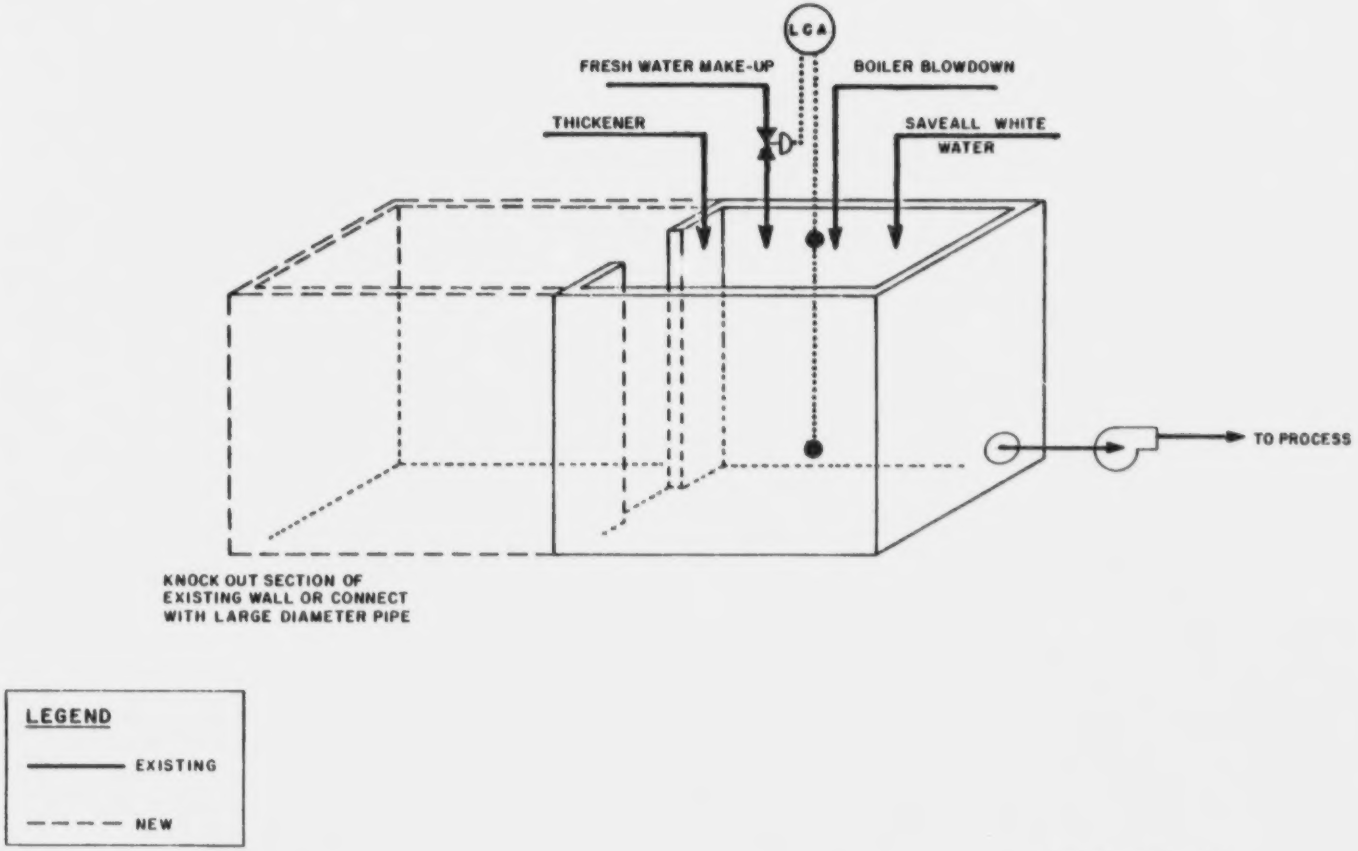

FRESH WATER MAKE-UP
LCA
BOILER BLOWDOWN
THICKENER
SAVEALL WHITE WATER
TO PROCESS
KNOCK OUT SECTION OF EXISTING WALL OR CONNECT WITH LARGE DIAMETER PIPE
LEGEND
EXISTING
NEW

FIGURE VII - 28
INCREASED WHITE WATER STORAGE CAPACITY

subcategory. The system consists of a central broke storage chest, pumps, and piping. This enables excess broke to be brought to the chest and returned to the proper machine once the upset is over. At some mills, more than one chest would be required, depending on the number of machines and product mix. Generally, the tank is sized to hold 30 minutes of broke from the couch pit. It would allow for breaks or grade changes to occur with a minimum of overflow to the sewers. Up to 10.0 kg/kkg (20.0 lb/t) TSS might be saved at a mill where grades are changed frequently.

Installation of Wet Lap Machines or Other Screening Devices. Wet lap machines or other screening devices can be installed at mills in several subcategories as part of an overall stock spill collection system. The wet lap machine would be preceded by a screen for removal of rejects and dirt from spilled stock. Rejects would be hauled to landfill. The accepts would be fed to the wet lap machine, allowing recovered stock to be stored in a convenient form for later reintroduction to the system or for use at another mill.

At some mills, devices such as sidehill or inclined screens may be effective at lower cost. However, the wet lap machine is very useful as a means of providing excess broke storage.

Segregation of Cooling Water. Improvements in cooling water segregation in the papermill could be employed resulting in reductions in water usage. Implementation of this control requires modifications to eliminate the discharge of pump seal, calender stack, bearing, and other cooling waters from the sewer. These waters could be collected in a sump and, depending on warm water requirements, either pumped to the mill water system or discharged via a separate thermal sewer. At least 4.2 kl/kkg (1.0 kgal/t) would be expected to be reduced in most nonintegrated mills.

Cleaner Rejects to Landfill. Collection and screening of rejects from sources such as pulp cleaners, papermill cleaners, pressure screens, and centrifugal screens will eliminate up to 40 percent of the solids to the treatment plant from these sources.(52)(60) The system would consist of piping from the reject sources to a collection tank, pump and piping to the screen headbox, a sidehill screen, and rejects dumpster. In the case of remote cleaner reject sources, an accepts tank and pump and piping from the accepts tank to the source for sluice water would be required. Savings of 1.5 to 5.0 kg/kkg (3.0 to 10.0 lb/t) TSS are possible. Figure VII-9 presented earlier, shows this modification.

For mills where ample primary clarifier capacity is provided, implementation of this technology may not result in significant improvement in overall treatment plant performance. These fiber losses may aid in the dewatering of combined primary/biological sludges.

Addition of Fourth Stage Cleaners. The addition of a fourth cleaner stage can reduce the flow and solids being discharged from a three stage system by 80 to 90 percent. The pulp stock savings alone can be ample justification for implementing such a system, shown in Figure VII-29. This control strategy may be an alternative to collection and screening of rejects depending on relative mill operating parameters. Again, if ample primary clarification is provided, this control may not result in significant improvement in overall treatment plant performance.

Steam Plant and Utility Areas

Production process controls that reduce raw waste loads in the steam plant and utility areas include: a) segregation of cooling waters and b) installation of lagoons for boiler blowdown and backwash waters. These controls are discussed below.

Segregation of Cooling Water. At mills in many subcategories, this control technology has been implemented; however, this technology is not widely practiced at mills in several subcategories. This control requires modifications to sewers and floor drains to segregate cooling water from the mill process sewer and installation of a warm water storage tank. The sources of cooling water that are to be handled by this system differ at mills in the various subcategories. Generally, they include miscellaneous streams such as pump and bearing cooling water, air compressor cooling water, and major water sources such as turbine and condenser cooling waters. This control is a flow reduction measure, but will also result in energy savings.

Addition of Lagoon(s) for Boiler Blowdown and Backwash Waters. This control could be effective at mills in many of the subcategories. At mills in several other subcategories, a separate discharge for these sources has been provided or these waters are reused in the process. The boiler blowdown water and the backwash waters can be pumped to a new lagoon, from which they are discharged to receiving waters. This keeps these sources segregated from the wastewater treatment facility and provides sufficient settling time to effectively remove suspended solids. pH adjustment may be required in some cases. Implementation of this control technology will reduce the flow to the wastewater treatment facility. While universally applicable, the technology is widely practiced at mills in only a few subcategories. (53)

Recycle of Effluent

At mills in several secondary fibers and nonintegrated subcategories, fresh water usage is reduced by recycling clarified effluent to the mill for use as hose water and pump seal water. At industrial tissue mills, purchased wastepaper requirements may be reduced through recycle of primary clarifier solids to the process. The major benefit of effluent recycle is flow reduction. Recycle of clarifier solids can yield savings in the cost of raw materials and the cost of handling and disposing of the primary waste solids.

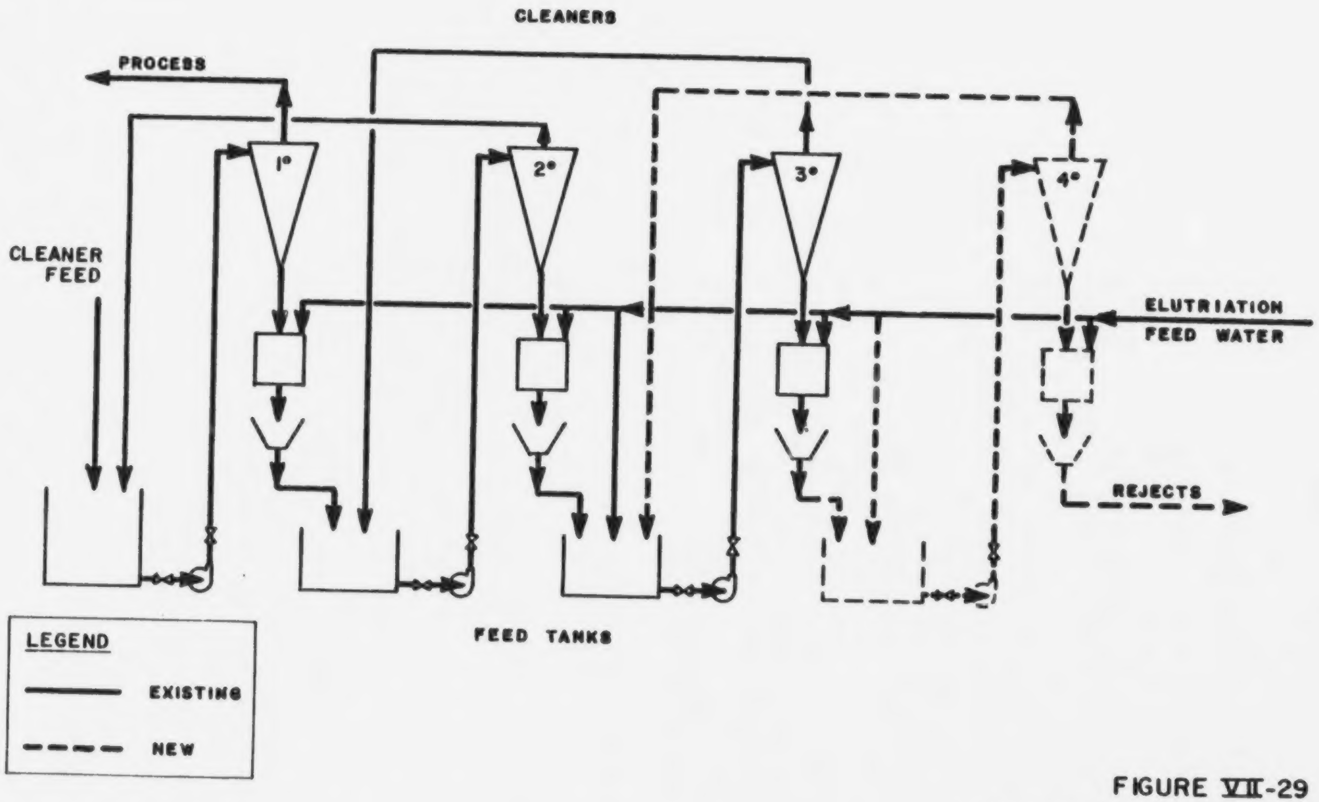

CLEANERS
PROCESS
CLEANER FEED
1°
2°
3°
4°
ELUTRIATION FEED WATER
REJECTS
FEED TANKS
LEGEND
EXISTING
NEW

FIGURE VII-29
4-STAGE CENTRICLEANER
SYSTEM WITH ELUTRIATION

One system to recycle clarified effluent would consist of a holding tank, piping from the clarifier to the holding tank, and a pump and piping from the holding tank to existing headers. The solids recycle system, as shown in Figure VII-30, would consist of a pump with suction from the existing waste solids discharge line and piping to the pulpers. This technology would be difficult to implement at mills with severe product quality constraints. It is most likely that this technology would be implemented at mills where industrial and institutional grades of tissue paper are produced. Solids recycle occurs primarily at secondary fiber mills.(67)

At some secondary fiber mills, effluent is now recycled. Saveall improvements could permit the use of more effluent on machine showers and eliminate the use of fresh water on the machine. Such recycle schemes are now commonly employed in the paperboard from wastepaper, wastepaper-molded products, and builders' paper and roofing felt subcategories. Savealls may serve as a means of recycling both effluent and reclaimed stock in these latter subcategories. At mills in the nonintegrated-tissue papers and nonintegrated-lightweight papers subcategories, a settling basin can be installed to collect discharges from floor drains for reuse of this water rather than fresh water for hoses and seal water. This system could also be employed at mills in the deink and nonintegrated-fine papers subcategories.

Chemical Substitution

It is often possible to use different process chemicals to accomplish the same goal. For example, both zinc hydrosulfite and sodium hydrosulfite can be used to bleach mechanical (groundwood) pulps. In recent years, at most groundwood mills, a substitution to the use of sodium hydrosulfite rather than zinc hydrosulfite has been made. This was prompted, at least in part, by the establishment of BPT effluent limitations controlling the discharge of zinc. Rather than invest in costly end-of-pipe treatment, mill management determined that a less costly and equally effective control option would be chemical substitution. This substitution of chemicals resulted in attainment of BPT effluent limitations.

Other opportunities exist to minimize the discharge of toxic and nonconventional pollutants through chemical substitution and are discussed below.

Toxic Pollutants. Slimicide and biocide formulations containing pentachlorophenol are used at mills in the pulp, paper, and paperboard industry. Initially, pentachlorophenol was used as a replacement for heavy metal salts, particularly mercuric types. Trichlorophenols are also used because of their availability as a by-product from the manufacture of certain herbicides. Formulations containing the following three types of materials are also currently being used:

1. Organo-bromides,
2. Organo-sulfur compounds, and
3. Carbamates.

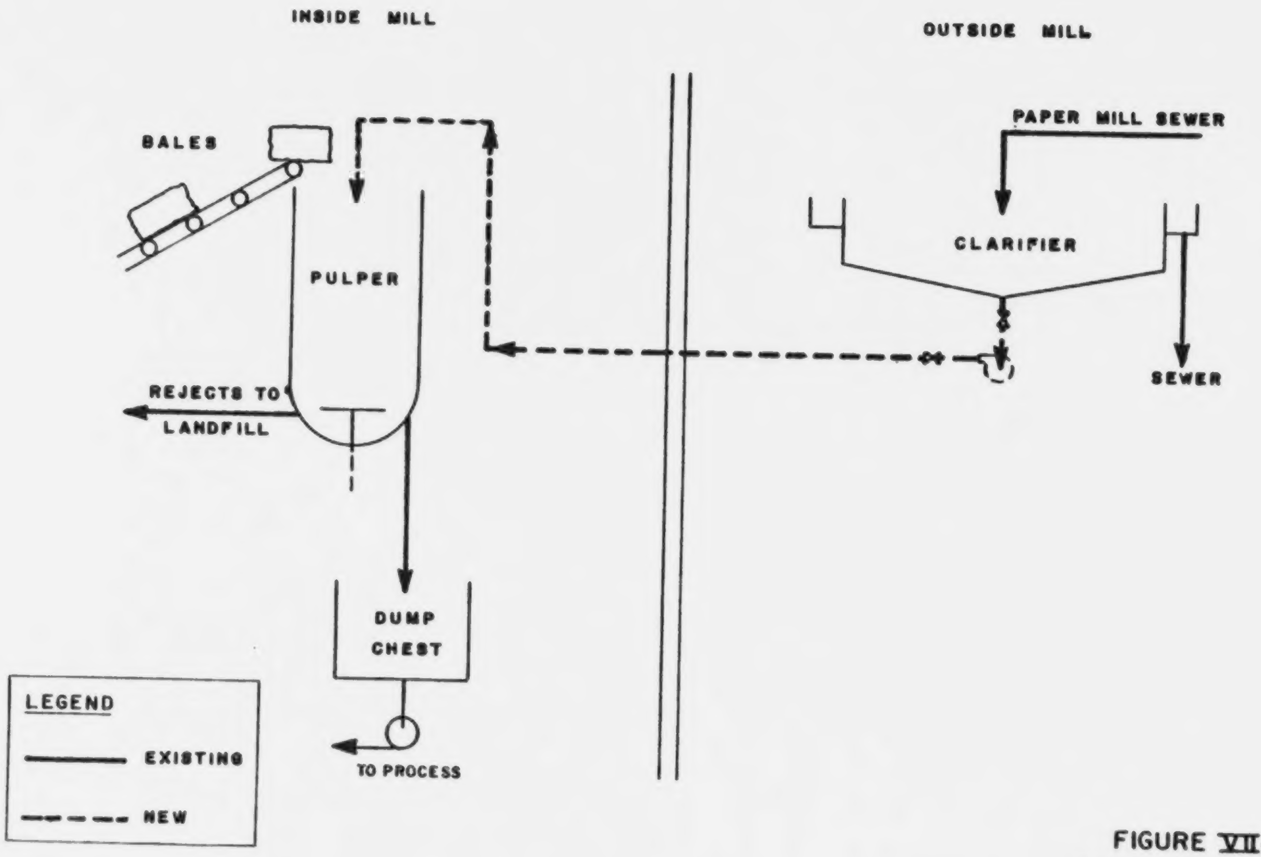

INSIDE MILL
OUTSIDE MILL
BALES
PULPER
REJECTS TO LANDFILL
DUMP CHEST
TO PROCESS
PAPER MILL SEWER
CLARIFIER
SEWER
LEGEND
EXISTING
NEW

FIGURE VII-30
IMPROVED REUSE
OF CLARIFIER SLUDGE

Substitution to the use of alternate slimicide and biocide formulations can lead to the virtual elimination of pentachlorophenol and trichlorophenol from these sources.

Nonconventional Pollutants. Ammonia is used as a cooking chemical at eight mills in the semi-chemical, dissolving sulfite pulp, and both papergrade sulfite subcategories. One method for reducing ammonia (NH_3) discharges is the substitution of a different chemical, such as sodium hydroxide, for ammonia in the cooking liquor. The quantity of sodium hydroxide required, based on chemical composition and stoichiometry, is 150 kg per kkg (300 pounds per ton) of pulp, about three times the required amount of NH_3. The equipment changes necessary to receive and feed a 50 percent solution of NaOH are not likely to be significant.

After conversion to the use of sodium-based chemicals, spent liquor could be incinerated, and sulfur dioxide, sodium sulfate, carbonate, or sulfide could be recovered. These compounds could be sold for use at nearby kraft mills or for other industrial uses; however, markets are not likely to be readily available.

Reducing, smelting furnaces that produce a high-sulfidity, kraft-like green liquor are now employed at sodium-based sulfite mills. The Agency anticipates that it would be necessary to replace the existing recovery boilers at ammonia-based mills if chemical substitution to a sodium base were employed. Additionally, it is likely that, because the heat value of sodium spent liquor is lower than ammonia spent liquor, evaporator modification may be required if excess capacity does not now exist.

OTHER PRODUCTION PROCESS CONTROLS

In the previous discussion, production process controls commonly employed in the pulp, paper, and paperboard industry have been reviewed and summarized. Other production process controls have been implemented to a limited extent; these controls are generally applicable in the pulping, bleaching, and recovery areas of the mill. Several of these control items are discussed below.

Bleach Systems and Recovery

The bleach plant is commonly the largest contributor of wastewater pollutants from kraft and soda mills where pulp is bleached. For this reason, much effort has been spent on investigating the possibility of recycling bleach plant effluent to the liquor recovery system, where organic constituents can be burned. One process that has been investigated is the use of oxygen bleaching. The oxygen bleaching concept has just recently begun to be applied in commercial use.(73)(74) Other processes that allow return of bleach plant effluent to the liquor recovery cycle are the Rapson-Reeve closed-cycle process and the Billerud Uddeholm nonpolluting bleach plant.(75)(76)(77)(78)

Oxygen Bleaching. Oxygen bleaching is currently used at only one mill in the United States, the Chesapeake Corporation in Virginia.(79) Oxygen bleaching is used outside the U.S., at one mill in Canada, one in South Africa, one in France, one in Japan, and three in Sweden.(80)

The advantage of oxygen bleaching comes from the recycling of the alkaline O_2 stage effluent to the black liquor recovery system. In order to recycle the effluent, it is necessary to keep the chloride content of the O_2 stage at a low level. For this reason, the O_2 bleaching sequences being used generally have the O_2 stage preceding any Cl_2 or ClO_2 stage. The exception to this is at the Chesapeake Corporation, where a C_DOD sequence is used that does not allow for recycle of the O_2 stage to the recovery system.

In work done by the NCASI, effluent characteristics from conventional and oxygen bleaching sequences were compared. The conventional sequences CEHDED and CEDED were compared in the lab to those from OCEDED and OCED for both hardwood and softwood alkaline pulps. By recycling all of the O_2 stage effluent, a BOD_5 reduction of 81 percent and a color reduction of 89 percent over the conventional sequences were achieved for softwood pulps. For hardwood, reductions of 81 percent of BOD_5 and 92 percent of color were achieved.(81)

At the Cellulose d'Aquitaine mill in St. Gaudens, France, total BOD_5 load and the total color load have reportedly been reduced by about 30 and 50 percent, respectively. An existing CEDED sequence has been converted to an OCEDED sequence.(73) The claimed operating cost for the new oxygen bleach sequence is $2.10/ton (1975) less than for the old sequence.

The Enstra oxygen bleaching operation in South Africa has achieved a cost reduction of $5.00/ton (1972) with an AODED sequence. The capital cost of adding an oxygen stage was reported to be $2.0 million (1972) for a 270 kkg/day (300 tons/day) mill and $4.0 million (1972) for a 680 kkg/day (750 tons/day) mill.(74)

Oxygen bleaching technology is still being developed and is not routinely used in alkaline pulp mills in the United States.

Rapson-Reeve Closed-Cycle Process. The Rapson-Reeve closed-cycle process encompasses some standard design features likely to be employed at many kraft pulp mills in the future. (53)(76) The concepts of the closed-cycle mill, as proposed by ERCO-Envirotech, Ltd. and illustrated in Figure VII-31, are included in the system at Great Lakes Paper Co., Ltd., Thunder Bay, Ontario.

One of the features of the closed-cycle process is the use of approximately 70 percent chlorine dioxide in the first stage. It has been claimed that the use of chlorine dioxide will decrease effluent BOD_5, color, chemical oxygen demand (COD), dissolved solids, and toxicity even at a mill that is not completely closed.(82) The bleach sequence for the closed-cycle bleached kraft mill is D_CEDED. The washing design is straight countercurrent; excess E_1 stage filtrate

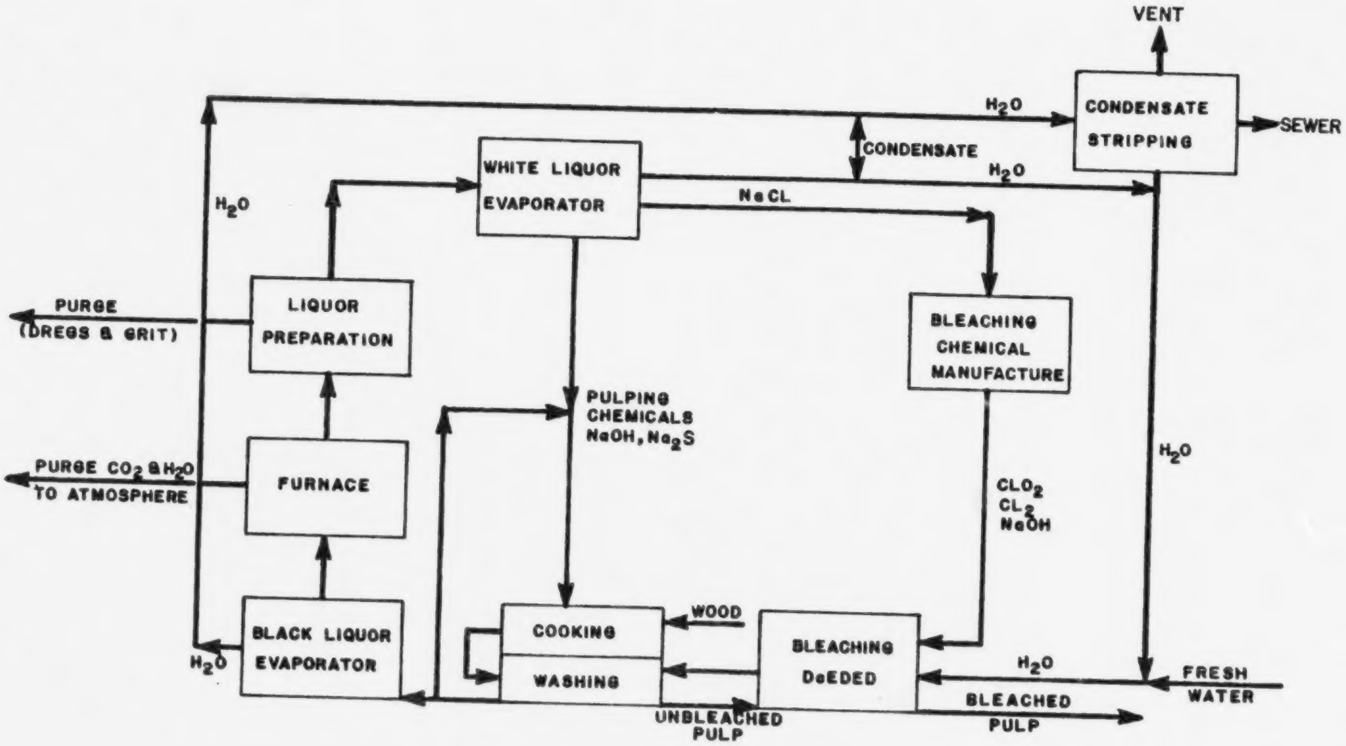

VENT
CONDENSATE STRIPPING
SEWER
H_2O
CONDENSATE
H_2O
WHITE LIQUOR EVAPORATOR
NaCL
H_2O
LIQUOR PREPARATION
PURGE (DREGS & GRIT)
BLEACHING CHEMICAL MANUFACTURE
PULPING CHEMICALS NaOH, Na_2S
FURNACE
PURGE CO_2 & H_2O TO ATMOSPHERE
H_2O
CLO_2 CL_2 NaOH
BLACK LIQUOR EVAPORATOR
H_2O
COOKING
WASHING
WOOD
BLEACHING DeEDED
H_2O
FRESH WATER
UNBLEACHED PULP
BLEACHED PULP

FIGURE VII-31
RAPSON - REEVE PROCESS
CLOSED CYCLE BLEACHED KRAFT PULP MILL

can be pumped to the salt recovery process, used for cooking liquor dilution, or used on the brown stock washers. The D_C filtrate can be used for brown stock washing, screen room dilution, or sent to the lime kiln scrubber.

Of these features, the only one that is unique to the closed-cycle mill is the salt recovery process. The salt recovery process (SRP) is necessary in the closed-cycle mill in order to remove the sodium chloride that would otherwise build up in the system. In the closed-cycle mill, the white liquor is evaporated and sodium chloride is crystalized and removed from the white liquor. Recovered salt is to be reused for the generation of ClO_2; however, some must be purged from the cycle. Figure VII-32 is a schematic of the salt recovery process.

ERCO-Envirotech stated that use of the design features of the closed-cycle mill result in (a) energy savings, (b) fiber savings, (c) yield increase, (d) decreased water consumption, (e) decreased chemical costs, and (f) savings in effluent treatment costs. According to ERCO-Envirotech, for a closed-cycle kraft mill producing 635 air dry kkg/day (700 air dry tons (ADT) per day), an SRP system would have a capital cost of $4.2 million (1977). Implementation of production process controls could run as high as $3.8 million (1977), making the total cost for a closed-cycle mill about $8 million or more. The additional ClO_2 generating capacity and any major bleachery modifications requiring more corrosion resistant materials will result in yet higher costs.(77) Original estimates predicted that savings of $4 million per year (1977) could be achieved when compared to a mill having none of the features of the closed-cycle mill.

Full-scale operating experience has been less favorable than the early literature had projected. Some contaminated effluent is being discharged and, while the salt recovery system has been operated, the recovered salt has not been used on-site.(75)(76) It was originally thought that chemical costs would be lower for a closed-cycle mill than for a conventional mill. However, actual chemical costs at Great Lakes Paper Co., Ltd. have been higher than for a conventional mill.(82)

On implementation of the closed-cycle system, corrosion problems occurred at the Thunder Bay facility. A combination of high temperatures (480°C (900°F)) and high chloride levels resulted in badly corroded tubes in the recovery boiler superheater. The damaged equipment was replaced with equipment made of Incaloy 880 and the superheater has been operated at lower temperatures (390°C (730°F)). This has permitted operation of the system without noticeable pitting.(83) In addition, liquor pump failures and evaporator scaling were the primary problems experienced in the initial operation of the SRP. Presently, liquor pump failures are no longer a problem and new evaporator boil out procedures (using E_1 filtrate) have significantly reduced scaling problems. At the request of representatives of the government of the province of Ontario, mill personnel had planned on constructing a biological treatment system. However, biological

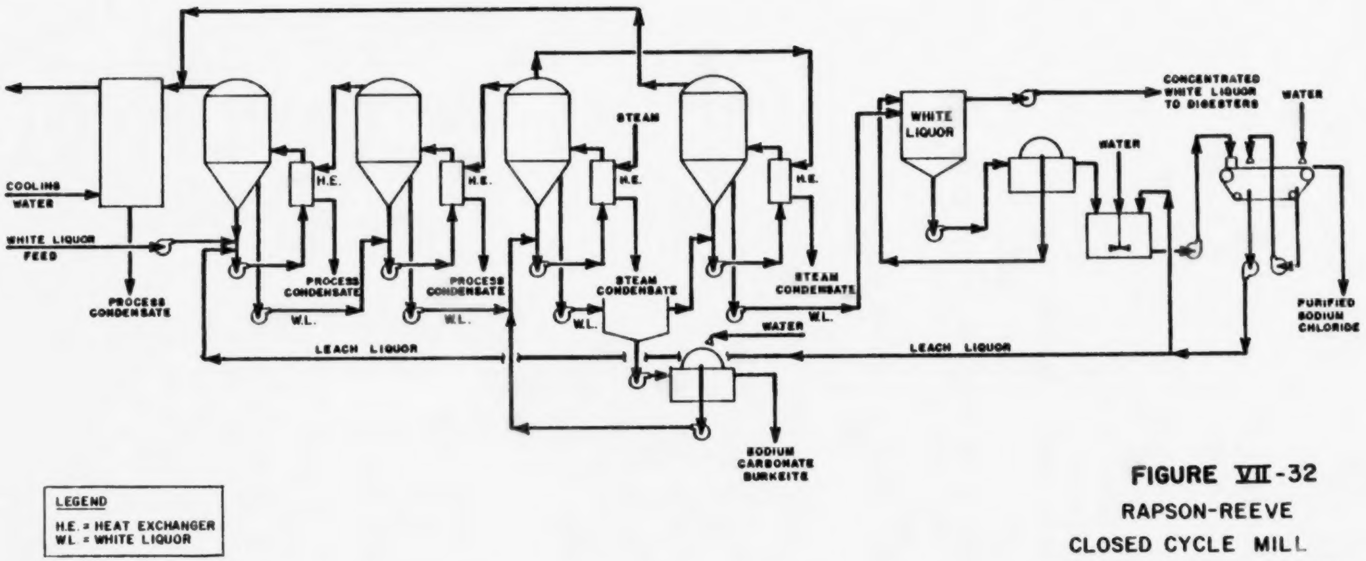

COOLING WATER
WHITE LIQUOR FEED
PROCESS CONDENSATE
H.E.
PROCESS CONDENSATE
W.L.
H.E.
PROCESS CONDENSATE
W.L.
STEAM
H.E.
STEAM CONDENSATE
W.L.
H.E.
STEAM CONDENSATE
W.L.
WATER
LEACH LIQUOR
SODIUM CARBONATE BURKEITE
WHITE LIQUOR
CONCENTRATED WHITE LIQUOR TO DIGESTERS
WATER
WATER
LEACH LIQUOR
PURIFIED SODIUM CHLORIDE
LEGEND
H.E. = HEAT EXCHANGER
W.L. = WHITE LIQUOR

FIGURE VII-32
RAPSON-REEVE
CLOSED CYCLE MILL
SALT RECOVERY SYSTEM

treatment is not currently contemplated because the effluent from this facility combined with that from another mill at this site is able to achieve provincial effluent standards. While the goal of an effluent-free mill has not been realized, reductions in the BOD$\underline{5}$ raw waste load of 50 to 75 percent of that of a typical market bleached kraft mill have been attained. Even higher reductions have been achieved when the SRP has been operated within the specified design load.(83)

Sequential Chlorination. Another method of reducing the pollution load from the bleach plant is with sequential chlorination.

Sequential chlorination is based on initially contacting the unbleached pulp with ClO$\underline{2}$ equal to a portion of the equivalent chlorine demand. The reaction is rapid; the remainder of the chlorine demand is satisfied with chlorine addition. Strength and viscosity improvements have been noted and total chemical application has been reduced.(84)

MacMillian Bloedel Research views the use of sequential chlorination as an interim solution while oxygen bleaching technology, ClO$\underline{2}$ generation, and salt recovery systems are developed. When these technologies are fully developed, lower capital expenditures may be realized.(85)

Hooker Chemical has investigated the use of sequential chlorination; their work has dealt with modification of fully bleached sequences. The first sequential chlorination system studied by Hooker Chemical was the APS-I. In this system, the standard CEHD or CEDED sequence is modified by replacing conventional chlorination with sequential chlorination at a D:C ratio of 50:50 and substituting a hypochlorination stage for the first extraction stage. The system can be used for hardwood or softwood pulps. Substantial reductions in effluent color and toxicity and moderate reductions in BOD$\underline{5}$ are reported.(84)

Chemical costs for the APS-I system are reported to be equivalent or slightly higher than for conventional sequences. Estimated capital costs range from $20,000 to $500,000 (1973) depending on the mill size and condition of the existing bleach plant. Pulp quality is equivalent to that from conventional bleaching sequences.

The Hooker APS-II and APS-III systems operate differently than the APS-I. Chlorination is replaced by sequential chlorination, at a D:C ratio (75:25) and conventional caustic extraction is employed. This minimizes the chloride content of the bleach plant effluent and permits recycling of the effluent into the kraft recovery system to allow incineration of a major organic waste load. The APS-II and APS-III systems suggest a sequence of antipollution steps that may be implemented one at a time. These steps and the BOD$\underline{5}$ and color reductions obtained through implementation of each step are shown in Table VII-4. This process is reported to involve the use of existing or slightly modified bleach plant equipment and produces pulp with

TABLE VII-4

WASTE LOAD REDUCTIONS FROM IMPLEMENTATION OF HOOKER APS II AND APS III SYSTEMS[1]

Step No., Operation	Effluent		BOD5		% BOD5 Reduction	Color		% Color Reduction
	kl/kkg	(kgal/t)	kg/kkg	(lb/ton)		kg/kkg	(lb/t)	
Control standard	75.1-83.4	(18 - 20)	12.5	(25)	-	325	(650)	-
APS II								
1. Countercurrent wash-jump stage, split flow	45.9-54.2	(11 - 13)	12.5	(25)	-	325	(650)	-
2. Replace chlorination with sequential chlorination - 75:25 D:C ratio	45.9-54.2	(11 - 13)	11.0	(22)	12	188	(376)	42
3. Recycle D/C effluent to dilute incoming brown stock	25.0-33.4	(6 - 8)	11.0	(22)	12	188	(376)	42
4. Dilute sequential chlorination stock with part E_1 and recycle remainder to recovery via brown stock washers and smelt dissolving system	16.7-25.0	(4 - 6)	5.0	(10)	60	43.5	(87)	87
5. Use salt separation process to purge NaCl and separate Na_2SO_4 from precipitator catch	16.7-25.0	(4 - 6)	5.0	(10)	60	43.5	(87)	87
APS-III								
6. Treat D/C effluent in a resin packed column and regenerate resin with a portion of E_1 effluent	16.7-25.0	(4 - 6)	4.5	(9)	64	11.5	(23)	96

---

[1] Gall, R.J., and F.H. Thompson, "The Anti-Pollution Sequence - A New Route to Reduced Pollutants in Bleach Plant Effluent," TAPPI, 56(11), 1973.(84)

properties equivalent to or superior to that of conventional processes. Hooker also claims reduced chemical and operating costs. The process allows for recovery of caustic, sodium sulfate, and sodium chloride that would normally be sewered.

Displacement Bleaching. There are presently only two mills in the country where a displacement bleaching process is used. The first was at the Temple Eastex mill in Evadale, Texas, where operation of displacement bleaching began in 1975.(86) This was followed by the start-up of a system at Weyerhaeuser Corporation in Plymouth, North Carolina, in 1976. Both systems are Kamyr designs, with a conventional D/C first stage tower and washer preceding an EDEDW displacement tower. The caustic is applied at the repulper of the conventional washer. The pulp is then pumped into the bottom of the displacement tower (D_1) at about 10 percent consistency. The displacement tower has a retention time of about 90 minutes. Each stage in the tower is followed by a stage of diffusion washing with the filtrate being extracted to a seal tank and then partially reused.(87) A final displacement tower (D_2) provides up to 4 hours detention and washing using paper machine white water at the Plymouth mill.

There are four filtrate tanks for the displacement towers. These tanks are of a stacked design with one set of tanks for each caustic extraction stage and one set for each chlorine dioxide stage. Caustic extract is generally reused on the conventional washer and is mixed with the NaOH added at the repulper of the conventional washer prior to pumping to the displacement tower. Some chlorine dioxide stage filtrate is also mixed with ClO_2 to be reused on the D_1 and D_2 stages. Overflows from the seal tanks are sewered. Water use for a D/CEDED displacement bleach sequence is typically 12.5 to 18.8 kl/kkg (3.0 to 4.5 kgal/t) compared to a conventional tower washer system often exceeding 50.0 kl/kkg (12.0 kgal/t).(86)

The benefits associated with displacement bleaching are lower water use and slightly lower initial capital costs. Based on limited data, it appears that chemical usage may actually be higher than for conventional bleaching systems.(86)

END-OF-PIPE TREATMENT TECHNOLOGIES COMMONLY EMPLOYED BY THE PULP, PAPER, AND PAPERBOARD INDUSTRY

Many types of wastewater treatment systems are employed at mills in the pulp, paper, and paperboard industry. This section describes the treatment systems employed by the industry and presents information on other applicable effluent treatment technologies.

Preliminary/Primary Treatment

Wastewater must often be screened to remove materials that could seriously damage or clog downstream treatment equipment. Automatically cleaned screens are commonly employed prior to primary treatment and generally represent the preferred practice.

The initial process of removing organic and inorganic solids can be accomplished by sedimentation (with or without flocculants or coagulants), flotation, or filtration. Primary treatment can involve mechanical clarifiers, flotation units, or sedimentation lagoons.

The most widely applied technology for removing solids from pulp, paper, and paperboard mill wastewaters is the mechanical clarifier. In the mechanical clarifier, solids are removed by simple sedimentation. Dissolved air flotation (DAF) units have also been applied to remove solids from paper mill effluents.(88) DAF units are somewhat limited in use because of their inability to handle high pollutant concentrations and shock loads. Fine screens, microstrainers, and pressure filters are not commonly used in the industry for solids removal. Adequate fine screening systems cost approximately the same as an equivalent clarifier.(89)

Because of the biodegradable nature of a portion of the settleable solids present in pulp, paper, and paperboard mill wastewaters, clarification can result in some BOD_5 reduction. Typical BOD_5 removal through primary clarification of integrated pulp and paper mill effluent can vary between 10 and 30 percent. The exact BOD_5 removal depends on the percentage of soluble BOD_5 present in the raw wastewater. Primary clarification can result in significantly higher BOD_5 reductions at nonintegrated mills than at integrated mills. Responses to the data request program indicate that approximately 50 percent of the raw wastewater BOD_5 is commonly removed at nonintegrated mills through the application of primary clarification.

Easty observed that very little reduction of fatty acids, resin acids, or their chlorinated derivatives occurs during primary clarification.(90) This observation suggests that these compounds are not associated with the raw wastewater solids measured in the TSS test procedure. Polychlorinated biphenyls (PCBs) have been observed to undergo significant reductions through primary treatment.(91) At a deink tissue mill, PCBs were reduced from 25 to 2.2 micrograms per liter (ug/l) through primary clarification, while TSS were reduced from 2,020 to 72 milligrams per liter (mg/l).(91)

Biological Treatment

Currently, the most common types of biological treatment used in the pulp, paper, and paperboard industry include oxidation basins, aerated stabilization basins, and the activated sludge process or its modifications. Other biological systems that have been used include rotating biological contactors and anaerobic contact filters.

A principal benefit obtained from biological treatment is the reduction of oxygen demand. Significant reductions in toxic pollutants have also been observed through application of biological treatment as illustrated by recent data gathering efforts (see Section V). Biological treatment systems have been designed and operated to achieve 80 to 95 percent and higher BOD_5 reductions when applied to pulp, paper, and paperboard mill effluents. Biological treatment can also yield an effluent nontoxic to fish a high percentage of the time.(92)

Due to the fluctuation of influent wastewater characteristics, specific toxic pollutant removal capabilities are not readily measureable unless long-term field sampling is employed. In a laboratory study, Leach, Mueller, and Walden determined the specific biodegradabilities of six nonconventional pollutants in pulp, paper, and paperboard mill wastewaters.(93) The relative ease with which these six compounds were degraded was, in descending order: dehydroabietic acid, pimaric acid, tetrachloroguiacol, monochlorodehydroabietic acid, dichlorodehydroabietic acid, and trichloroguaiacol. The researchers reported that chlorinated bleach plant derivatives are more difficult to degrade than are the nonchlorinated wood derivatives.

A recent study involved investigation of influent and effluent concentrations of toxic and nonconventional pollutants after full-scale biological treatment.(90) Removal rates of these pollutants, as derived from the published design and treatment data, are shown in Table VII-5.(90) The relative removal rates generally agree with those obtained in laboratory studies.(90)(93)

BOD_5 and toxic pollutant removals from bleached kraft wastewater through application of activated sludge treatment and aerated stabilization were investigated in an attempt to establish a relation between pollutant concentration and toxicity.(92) The authors concluded that, in general, a reduction in BOD_5 to about 45 mg/l was sufficient to achieve detoxification of the waste. Also, a total resin and fatty acid concentration of less than 1 mg/l was necessary to effect detoxification. The correlation between total resin and fatty acid content and toxicity was better than the correlation between BOD_5 and toxicity.

Oxidation Basins. The first type of biological treatment systems used in the pulp, paper, and paperboard industry were oxidation basins. These are large natural or manmade basins of various depths; natural aeration from the atmosphere is relied on as the primary oxygen source. Additionally, limited oxygen is provided by algal photosynthesis. The amount of oxygen provided through photosynthesis is dependent upon the basin configuration (depth) and its restriction in light penetration. Since oxidation through natural aeration is a relatively low-rate process, large land areas are required to effectively treat high strength wastes. Because of availability of land and a warm climate that enhances bioactivity, most oxidation basins are found in southern states. This technology can be more effective if settleable solids are removed from the wastewater prior to discharge to the basins. Solids can, in certain instances, contribute significantly to the BOD_5 waste loads. In addition, excess settleable solids tend to fill the basins, thus reducing detention time.

TABLE VII-5

CALCULATED TOXIC AND NONCONVENTIONAL POLLUTANT REMOVAL RATES[1](a)

	Mill 9(b) 10-Day ASB	Mill 11(b) 6-Day ASB	Mill 12(c) 3.5-Hr AS	Mill 13(b) 12-Day ASB	Mill 14(b) 7-Day ASB	Mill 15(b) 15-Day ASB
Resin Acids						
Abietic	0.85	0.86	0.3	1.5	1.0	0.45
Dehydroabietic	1.05	2.65	0.6	1.85	1.1	0.72
Isopimaric	0.30	0.37	0.26	1.25	3.0	0.12
Pimaric	0.10	0.14	0.3	0.3	0.1	0.15
Unsaturated Fatty Acids						
Oleic		0.7	0.35	0.55		0.67
Linoleic		2.6	0.30	0.15		0.47
Linolenic		0.4				
Other Acidics						
Epoxysteric Acid						0.03
Dichlorosteric Acid				10.4		0.12
Chlorinated Resin Acids						
Monochlorodehydroabietic		0.10	0.006	0.03		0.01
Dichlorodehydroabietic		0.05	0.019	0.10		0.03
Chlorinated Phenolics						
Trichloroguaiacol		0.03				
Tetrachloroguaiacol		0.02				
Chloroform		2.2	2.1			

(a) Removal rates shown as micrograms removed per milligrams/liter (mg/l) of biomass per day.
(b) Aerated stabilization basin (ASB) biomass assumed to be 200 mg/l.
(c) Activated sludge (AS) biomass reported to be 2,500 mg/l.
NOTE: Blank spaces indicate no data.

[1] Source: Easty, Dwight B., L.G. Borchardt, and B.A. Wabers, Institute of Paper Chemistry, Removal of Wood Derived Toxics from Pulping and Bleaching Wastes, U.S. Environmental Protection Agency, Cincinnati, OH, EPA 600/2-78-031, 1978.(90)

Typical design BOD5 loads range from 56 to 67 kilograms per hectare (kg/ha) of surface area/day (50 to 60 lb/acre/day).(48) Retention times can vary from 20 to 60 days or more.(48) This method of treatment has two principal advantages: a) it can be capable of handling (buffering) accidental discharges of strong wastewater without significant upset and b) it requires no mechanical devices with inherent maintenance problems. Oxidation basins have been used to effectively treat pulp, paper, and paperboard industry wastewaters. Generally, suspended solids are effectively removed in oxidation basins. However, high levels of suspended solids have been noted due to algal carryover. Literature presenting data on the removal of toxic and nonconventional pollutants through application of oxidation basin technology is limited.

Aerated Stabilization Basins (ASBs). The aerated stabilization basin (ASB) evolved from the necessity of increasing performance of existing oxidation basins due to increasing effluent flows and/or more stringent water quality standards. Induced aeration provides a greater supply of oxygen, thus substantially reducing the retention time required to achieve treatment comparable to that attained in an oxidation basin. Nitrogen and phosphorus (nutrients) are usually added prior to the ASB if the wastewater is nutrient deficient. These additions are commonly made in the form of ammonia and phosphoric acid. The longer the retention period of the waste undergoing biological oxidation, the lower the nutrient requirement. The specific detention time used depends upon the characteristics of the wastewaters to be treated. Retention times of 8 to 10 days, and sometimes up to 15 days, have been used in order to obtain low levels of BOD5.(94) The specific detention time used depends upon the characteristics of the wastewaters to be treated.

Aeration is normally accomplished using either mechanical surface aerators or diffused air. Oxygen transfer efficiencies under actual operating conditions range from 0.61 to 1.52 kilograms (kg) of oxygen per kilowatt-hour (kwh), or about (1.0 to 2.5 lb of oxygen per horsepower-hour) depending on the type of equipment used, the amount of aeration power per unit volume, basin configuration, and the biological characteristics of the system.(95)(96) It is necessary to maintain a dissolved oxygen (DO) level of 0.2 to 0.5 mg/l in the basin to sustain aerobic conditions.

BOD5 and suspended solids levels, oxygen uptake, and DO levels throughout the basins are related to aerator location and performance and basin configuration. There have been extensive studies of eleven existing aerated stabilization basins that have led to development of design criteria to aid in the design of future basins.(97)

Some solids accumulate in the bottom of ASBs that can be removed with periodic dredging. Solids accumulation diminishes as the detention time and degree of mixing within the basin increases. At some mills, a quiescent zone, settling basin, or clarifier is used to improve effluent clarity and to reduce suspended solids.

The toxicity removal efficiency of an ASB treating unbleached kraft waste was evaluated over a one-month period in late 1976.(98) Although the raw wastewater exhibited an LC-50 of from one to two percent by volume, all but one of the 26 treated effluent samples were either nontoxic or exhibited greater than 50 percent fish survival after 96 hours of exposure. The one failure was attributed to a black liquor spill at the mill. Average reductions of 87 percent BOD5, 90 percent toxicity, and 96 percent total resin acids were achieved. Dehydroabietic acid was the only resin acid identified in the treated effluent; pimaric, isopimaric and abietic acids tended to concentrate in the foam from the effluent.

Pilot-scale ASB treatment of bleached kraft wastewater was evaluated over a five month period.(92) Two basins, one with a five day and one with a three day hydraulic detention time, were studied with and without surge equalization. The raw wastewater BOD5 varied from 108 mg/l to 509 mg/l and was consistently toxic. The median survival times (MST) of fish ranged from 7 to 1,440 minutes, while total resin and fatty acid concentrations ranged from 2 to 9 mg/l.(92) Mean BOD5 removals with surge equalization were 85 percent for the five day basin and 77 percent for the three day basin. Mean effluent BOD5 levels with surge equalization were 40 mg/l for the five day basin and 59 mg/l for the three day basin. Detoxification was attained 98 percent of the time by the five day basin with surge equalization and 85 percent of the time by the three day basin with surge equalization. Mean reported effluent BOD5 values for the five day and three day basins without equalization were 51 mg/l and 67 mg/l, respectively. The detoxification rate without equalization dropped to 73 percent for the five day basin and 70 percent for the three day basin. The authors concluded that surge equalization appeared to have a more significant effect on detoxification than BOD5 removal. Since the surge capacity of an aerated stabilization basin is related to hydraulic detention time, the eight to ten day basins which are commonly employed in the pulp, paper, and paperboard industry in the United States could have a higher capacity for shock loading than those used in this study.

Aerated stabilization basins provide a high degree of BOD5 reduction and also can remove or reduce the wastewater toxicity. ASB capital and operating costs may be lower than those for the activated sludge process. The treatment efficiency is not as dependent on ambient air temperature as with oxidation basins; however, efficiency can be more dependent on ambient air temperature for ASBs than for higher rate processes (i.e., activated sludge).(99)

Activated Sludge Process. The activated sludge process is a high-rate biological wastewater treatment process. The biological mass (biomass) grown in the aeration basins is settled in a secondary clarifier and varying amounts of this biomass are returned to the aeration basins, building up a large concentration of active biological material. It is common to maintain 2,000 to 5,000 mg/l of active biological solids in the aeration basin section of the activated sludge system compared to the 50 to 200 mg/l common to aerated stabilization basins. Loadings in excess of 1.6 kilograms of BOD_5 per cubic meter (100 lbs of BOD_5 per 1,000 ft^3) of aeration capacity per day are sometimes used, allowing for relatively small aeration basins.

The characteristically short detention times tend to make the activated sludge process more susceptible to upset due to shock loads. When the process is disrupted, it may require several days for biological activity to return to normal. Particular operator attention is required to avoid such shock loadings at mills where this process is employed. The necessity for strict operator attention can be avoided through provision of sufficient equalization to minimize the effects of shock loadings.

Compared with aerated stabilization basins, the activated sludge process has less shock load tolerance, greater solids handling requirements, and higher costs. However, the activated sludge process requires less land than ASBs. Thus, it may be preferred in cases where sufficient land for ASB installation is either unavailable or too expensive.

The activated sludge process is very flexible and can be adapted to many waste treatment situations. The activated sludge process has many modifications that can be selected as most appropriate. Various types of activated sludge processes that have been applied to treat pulp, paper, and paperboard wastewaters include: a) conventional, b) complete-mix, c) tapered aeration, d) step aeration, e) modified aeration, f) contact stabilization, g) extended aeration, h) oxidation ditch, and i) pure oxygen. Another process, the Zurn-Attisholz process consists of a two stage system. Table VII-6 summarizes standard design parameters for the activated sludge process and several of its modifications.(100)

In the conventional activated sludge process, both influent wastewater and recycled sludge enter the aeration basin at the head end and are aerated for a period of about four to eight hours or more. Mechanical surface aerators similar to those used in aerated stabilization basins are used; the use of diffused air is becoming more common. Normally, the oxygen demand decreases as the mixed liquor travels the basin length. The mixed liquor is settled and the activated sludge is generally returned at a rate of approximately 25 to 50 percent of the influent flow rate.

In the complete-mix activated sludge process, influent wastewater and recycled sludge enter the aeration basin at several points along the length of the basin. The mixed liquor is aerated at a constant rate as it passes from the central channel to effluent channels at both sides of the basin. The contents of the basin are completely mixed and the oxygen demand remains uniform throughout. The aeration period is from three to five hours or more, and the activated sludge is returned at a typical rate of 25 to 100 percent of influent flow rate.

TABLE VII-6

TYPICAL DESIGN PARAMETERS FOR ACTIVATED SLUDGE PROCESSES[1]

Process Modification	Parameter		
	Volumetric loading (lb BOD5/1,000 cu ft)	MLSS (mg/l)	Detention Time V/Q (hr)
Conventional	20-40	1,500-3,000	4-8
Complete mix	50-120	3,000-6,000	3-5
Step aeration	40-60	2,000-3,500	3-5
Modified aeration	75-150	200-500	1.5-3
Contact stabilization	60-75	(1,000-3,000)(a) (4,000-10,000)(b)	(0.5-1.0)(a) (3-6)(b)
Extended aeration	10-25	3,000-6,000	18-36
Pure oxygen systems	100-250	6,000-8,000	1-3

(a) Contact unit.
(b) Solids stabilization unit.
MLSS = Mixed Liquor Suspended Solids
V = Volume
Q = Flow

[1] Source: Metcalf and Eddy, Inc., Wastewater Engineering, McGraw-Hill Co., 1972 (100)

The tapered-aeration process is a modification of the conventional process with the primary difference being the amount of air supplied. At the head of the basin, where wastewater and returned sludge come into contact, more oxygen is required. As the mixed liquor traverses the aeration basin, the oxygen demand decreases so aeration is decreased. Since the oxygen supply is decreased with the oxygen demand, a lower overall oxygen requirement can be achieved.

The step-aeration process also is a modification of the conventional activated sludge process. In this modification, the wastewater is introduced at several points in a compartmentized basin while the return activated sludge is introduced at the head of the basin. Each compartment of the basin is a separate step with the several steps linked together in series. Aeration can be of the diffused or mechanical type and is constant as the mixed liquor moves through the tank in a plug-flow fashion. The oxygen demand is more uniformly spread over the length of the basin than in the conventional activated sludge process, resulting in better utilization of the oxygen supply. The aeration period is typically between three and five hours and the activated sludge is returned at a typical rate of 25 to 75 percent of influent flow rate.

The contact-stabilization process takes advantage of the absorptive properties of activated sludge through operation in two stages. The first is the absorptive phase in which most of the colloidal, finely suspended, and dissolved organics are absorbed in the activated sludge in a contact basin. The wastewater and return stabilized sludge enter at the head of the contact basin, are aerated for a period of 30 to 60 minutes or more, and settled in a conventional clarifier. The second stage is the oxidation phase, in which the absorbed organics are metabolically assimulated providing energy and producing new cells. In this stage, the settled solids from the absorptive stage are aerated for a period of from three to six hours or more in a stabilization basin. A portion of the solids are wasted to maintain a constant mixed liquor volatile suspended solids (MLVSS) concentration in the stabilization basin. Contact stabilization has been applied successfully at several facilities to treat kraft mill wastewaters.

The extended-aeration process is a complete-mix activated sludge process in which the aeration period is relatively long (18 to 36 hours or more) and the organic loading relatively low. Because of these conditions, the process is very stable and can accept intermittent loads with minimal or no upset. The solids settled in the clarifiers are recirculated to the influent of the aeration basins. Through this process, a mass of biological solids are built up in the aeration basin. This biomass assists in achieving high treatment efficiencies through removal of dissolved organic matter in the wastewater by oxidation. Excess secondary solids, if present, are wasted from the process. Oxygen may be provided by either mechanical or diffused aeration. This process has been applied successfully throughout the pulp, paper, and paperboard industry. In northern climates, where temperature can impact the system performance, the extended-aeration process offers the stability of an ASB system and the high treatment efficiency of the activated sludge process.

The oxidation ditch activated sludge process is an extended-aeration process in which aeration and circulation are provided by brush rotors placed across a race track-shaped basin. The wastewater enters the ditch at one end, is aerated, and circulates at about 0.3 to 0.6 meters per second (1 to 2 fps). Operation can be intermittent, in which case clarification takes place in the ditch, or continuous, in which case a separate clarifier and piping for recycling of settled solids are provided.

The ability of activated sludge basins to detoxify bleached kraft mill effluents was analyzed over a five month period.(92) Two pilot-scale activated sludge systems (8-hr and 24-hr detention) were operated with and without surge equalization. Raw wastewater BOD$_5$ varied from 108 to 509 mg/l. The raw wastewater was consistently toxic. Reported raw wastewater median survival times (MST) to fish ranged from 7 to 1,440 minutes. Total resin and fatty acid concentrations in the raw wastewater ranged from 2 to 9 mg/l.

Mean BOD$_5$ removals for the 8-hr and 24-hr activated sludge systems with a 12-hr surge equalization basin achieved an average of 72 percent and 76 percent BOD$_5$ removal, respectively. Effluent BOD$_5$ concentrations for the 24-hr system ranged from 5 mg/l to 263 mg/l, with a mean of 59 mg/l. The 24-hr system detoxified the effluent 87 percent of the time. Final effluent BOD$_5$ concentrations for the 8-hr system ranged from 14 to 270 mg/l with a mean of 70 mg/l. The effluent was detoxified 89 percent of the time.(92)

The 24-hr activated sludge system, when operated without equalization, was subjected to more vigorous mixing plus the addition of 10 mg/l alum. Under these conditions, an average of 90 percent BOD$_5$ removal was obtained and detoxification was achieved 100 percent of the time. The 8-hr activated sludge system, when operated without surge equalization, was also subjected to more vigorous mixing with no addition of alum. Under these conditions, an average of 84 percent BOD$_5$ removal was obtained, although detoxification was attained only 55 percent of the time.(92) The authors concluded that equalization did not affect BOD$_5$ removal efficiency, but improved the detoxification efficiency by 15 to 30 percent. Addition of alum to the activated sludge system appeared to reduce toxicity. The authors speculated that the mechanism of toxicity removal was a chemical reaction.(92) Failures to detoxify were attributed in some instances to hydraulic shocks, black liquor spills, or inadequate treatment system operation, although in many instances no cause could be determined.(92)

The pure oxygen activated sludge process uses oxygen, rather than air, to stimulate biological activity. This scheme allows for a lesser detention time and a lower aeration power requirement than for the conventional activated sludge process; however, additional power is required for oxygen generation which may result in a net increased power requirement. Waste secondary solids volumes that must be dewatered and disposed of are similar to those produced by air activated sludge systems.

Field test data by Union Carbide Corp. confirms that the oxygen activated sludge process is capable of achieving final effluent BOD_5 concentrations on the order of 15 to 30 mg/l when applied to unbleached kraft wastes.(101) Effluent TSS after clarification was generally in the range of 40 to 60 mg/l.(101) A summary of pilot-scale information is presented in Table VII-7.

A sulfite-newsprint effluent was treated using an oxygen activated sludge pilot plant facility over an 11 month period. BOD_5 reductions during this time were over 90 percent.(102) Final BOD_5 and TSS concentrations ranged from 23 to 42 mg/l and 61 to 111 mg/l, respectively.(102) The effluent from the oxygen activated sludge system was found to be acutely toxic.(102) Total resin acids before and after oxygen activated sludge treatment were 25 and 6 mg/l, respectively.(102) Ammonia was found at levels on the order of 50 mg/l. The treated effluent was air stripped to determine if ammonia was the major cause of the high toxicity. Although air stripping reduced the ammonia concentration to less than 1 mg/l and the total resin acid concentration to 1 mg/l, the effluent remained acutely toxic.

Easty studied two examples of pure oxygen activated sludge systems: one treating integrated bleached kraft wastewater and the other treating unbleached kraft pulp mill wastewater.(90) Both significantly reduced all identified pollutants. The pollutants evaluated included resin and fatty acids, their chlorinated derivatives, and chloroform. The first system incorporated an oxygen activated sludge basin with hydraulic detention of 190 minutes and a sludge recycle rate of 35 percent. The pH was maintained between 6.2 and 7.5. It was determined from Easty's data that 43 to 92 percent of identified pollutants were removed, with the chlorinated resin acids exhibiting relatively low removal efficiencies. This is consistent with observed biodegradabilities of bleach plant derivatives.(103)

The second oxygen activated sludge system was operated at a detention time of 3.7 hours and a mixed liquor suspended solids (MLSS) concentration of 2,500 mg/l.(90) Bench-scale alum/polyelectrolyte coagulation followed. The effluent was adjusted to a pH of 5 with alum; 1 mg/l of polyelectrolyte was added. Essentially complete removal of all identified resin and fatty acids was obtained. It should also be noted that initial concentrations in the raw waste were relatively low. Since no data were reported for the oxygen activated sludge system without chemically assisted clarification, the relative effects of each of the two processes on removal efficiencies could not be determined.

The Zurn/Attisholz (Z/A) process is a two-stage activated sludge system. The first stage operates at a DO of less than 1.0 mg/l; the DO level in the second stage is maintained at 4 to 5 mg/l. Nutrient

TABLE VII-7

OXYGEN ACTIVATED SLUDGE TREATABILITY PILOT SCALE[1]

Production Process	Retention (Hr)	BOD5 (mg/l)		TSS (mg/l)	
		Influent	Effluent	Influent	Effluent
Alkaline-Unbleached	1.3 - 2.2	277 - 464	20 - 41	57 - 86	46 - 61
Alkaline-Unbleached	1.8 - 3.0	214 - 214	16 - 22	123 - 123	36 - 36
Alkaline-Unbleached	2.0 - 2.9	265 - 300	25 - 30	95 - 120	60 - 70

---

[1] Source: Technical data supplied by Union Carbide Corp.(101)

and power requirements for the two-stage system are similar to those for the conventional activated sludge process. A total Z/A detention time of four hours may be required to achieve BOD$_5$ and TSS reductions comparable to activated sludge and aerated stabilization basin systems.

Seven full-scale Zurn/Attisholz systems are currently in use at pulp, paper, and paperboard mills in the United States. These installations treat wastewaters from the following types of manufacturing:

Deink(Fine or Tissue)	(5 mills)
Papergrade Sulfite	(1 mill)
Groundwood-Fine Papers	(1 mill)

At most of the mills where the Zurn/Attisholz process is used, final effluent BOD$_5$ and TSS concentrations in the range of 20 to 25 mg/l are attained.(104) At one mill, BOD$_5$ and TSS levels in the range of 5 to 10 mg/l are attained.(104) At another mill, 96 percent BOD$_5$ and 99 percent TSS reductions are attained using the Z/A process.(105)

A pilot study comparing a two-stage to a single-stage activated sludge system was recently performed. The authors concluded that the two-stage system achieved a higher toxicity reduction in treating bleached kraft wastewater than did a single-stage system.(106)(107)

Rotating Biological Contactor (RBC). This system involves a series of discs on a shaft supported above a basin containing wastewater. The discs are 40 to 45 percent submerged in the wastewater and are slowly rotated; a biological slime grows on the disc surfaces. Closely spaced discs with a diameter of 3.7 meters (12 ft) mounted on a 7.6 meter (25 ft) shaft can result in 9,300 square meters (100,000 sq ft) of surface area.

Pilot-scale evaluations of an RBC system treating bleached kraft wastewater with an average influent BOD$_5$ concentration of 235 mg/l have resulted in substantial BOD$_5$ reductions.(108) The degree of removal is related to the hydraulic loading rate, as seen in Table VII-8. Secondary waste solids production reportedly ranged from 0.3 to 0.5 kg of solids per kg of BOD$_5$ removed (0.3 to 0.5 lb of solids per lb of BOD$_5$ removed).(108)

Two pilot plant evaluations reported essentially complete detoxification of board mill, integrated kraft, and magnesium-based sulfite mill effluents.(109) Final effluent BOD$_5$ of 59 mg/l for the kraft mill, 65 mg/l for the board mill, and 338 mg/l for the sulfite mill were reported. Raw wastewater BOD$_5$ levels for these mills were 290 mg/l, 285 mg/l, and 1,300 mg/l, respectively. No TSS data were reported.(109) This pilot plant work indicates good toxicity and BOD$_5$ reduction capabilities. However, to date, mill-scale systems in the United States treating pulp mill wastewater have encountered operating difficulties.

TABLE VII-8

PILOT RBC FINAL EFFLUENT QUALITY FOR BLEACHED KRAFT WASTEWATER[1]

Hydraulic Loading Rate (gpd/sq ft)	70% of Time Final Effluent BOD5 Less Than (mg/l)	90% of Time Final Effluent BOD5 Less Than (mg/l)
3	70	90
2	30	45
1	22	39

Note: Raw Effluent BOD5 = 235 mg/l.

[1] Source: Gillespie, W.J., D.W. Marshall, and A.M. Springer, A Pilot Scale Evaluation of Rotating Biological Surface Treatment of Pulp and Paper Wastes, NCASI, TAPPI Environmental Conference, April 17-19, 1974.(108)

Anaerobic Contact Filter. This process involves the use of a basin filled with crushed rock or other media. Wastewater is passed through the media at a temperature of 32° to 35°C (90° to 95° F) under anaerobic conditions; detention times on the order of three days are common. Steam stripping, nutrient addition, neutralization, and dilution of waste liquor with wash water may be required as pretreatment.

A laboratory study of this process showed that 80 to 88 percent BOD_5 removal from sulfite wastewaters have been achieved.(110) The major advantage of the process is a low solids production rate of 0.08 kilograms of solids per kilogram of BOD_5 removed (0.08 pounds of solids per pound of BOD_5 removed). This is because methane gas, rather than biological solids, is the by-product of anaerobic digestion. The author concludes that the cost for the anaerobic process was approximately the same as that for aerated stabilization.(110)

Impact of Temperature Variations. All biological treatment systems are affected by temperature, particularly by large and/or sudden temperature changes. The effect of temperature variations on aerobic biological systems has been demonstrated in both theory and practice; therefore, temperature is of importance in the choice of design and operation of treatment systems. McKinney stated that all processes of growth are dependent on chemical reactions and the rates of these reactions are influenced by environmental conditions, including temperature.(111) The discussion below presents theoretical and operating data on temperature variations and their effects. Included is an evaluation of the effect of temperature on biological treatment system performance as measured by BOD_5 and TSS removals.

BOD_5 is a measure of the dissolved oxygen used by microorganisms for the biochemical oxidation of organic matter in a wastewater. Biochemical oxidation occurs in two stages: a first stage in which the carbonaceous (organic) matter is oxidized and a second stage in which nitrification occurs. The oxidation of the carbonaceous matter results from the biological activity of bacteria and other organisms in the wastewater. For a stated set of environmental conditions, the growth rate of microorganisms is predictable and reproducible and related to the amount of organic matter present in a wastewater, measured as BOD_5, and the rate at which the organic matter is consumed by the microorganisms present.(112)

The heterogeneous population of bacteria found in aerobic biological systems treating wastewaters at temperatures resulting from the production of pulp, paper, and paperboard includes three types of bacteria: psychrophilic, mesophilic, and thermophilic organisms.

Seasonal wastewater temperature variations change the specific growth rate of the heterogeneous population and, to a lesser extent, the relative distribution of the types of bacteria comprising the population. McKinney (111) depicted the rate of growth for mesophilic organisms with the maximum rate occurring in the range of 35° to 40°C

(95° to 104°F). Similar growth rate/temperature distributions exist for both psychrophilic and thermophilic organisms, with the optimal growth rate occurring in the range of 10° to 15°C (50° to 59°F) for psychrophiles, and 60° to 65°C (140° to 149°F) for thermophiles.(103) However, the predominant group found at all normal operating temperatures in aerobic systems are the mesophiles.(100)

A number of studies have been conducted to quantify various aspects of microbial growth, temperature, and BOD5 reduction. Degradation of organic matter in pulp, paper, and paperboard wastewaters has been evaluated and found to proceed at rates similar to other wastewater sources.(100)(113)(114)(115)(116)(117)(118)

Soluble BOD5 reduction by microorganisms approximates first-order kinetics.(100) A temperature decrease of 10°C (18°F) from the optimal temperature would necessitate an increase in detention or reaction time of approximately 35 percent to attain the same effluent BOD5 level as that attained at the optimal temperature. Conversely, an increase in temperature of 10°C (18°F) would theoretically shorten the detention time by 25 percent to attain the same effluent BOD5 level.

The above concept is of substantial practical importance in treatment system design, since flexiblity in design allows treatment systems to sustain efficient operation over a wide range of conditions (i.e., decreasing microbial (solids) wastage rates will increase waste/microbe contact time when microbial activity is reduced in colder temperatures). An additional study relates the specific effects of changes in temperature on BOD5 and suspended solids reduction to performance for specific systems.(99)

Ammonia Removal Through Nitrification. One method of ammonia removal is through single-stage nitrification in a biological treatment system. Nitrification is the process where specific bacteria, Nitrosomonas and Nitrobacter, oxidize ammonia to nitrite nitrogen and then to nitrate nitrogen.

Biological treatment systems presently employed at mills in the pulp, paper, and paperboard industry are generally designed and operated for oxidation of organic material (i.e., BOD5 reduction). It is possible, however, to design and operate these systems to accomplish BOD5 and ammonia reduction in a single step or in a series of steps. Nitrifying organisms exhibit a very slow growth rate in comparison to organic assimilation and are very sensitive to environmental conditions and growth inhibitors, such as toxic organic wastes and heavy metals. Growth rates and, thus, nitrification rates are profoundly influenced by such environmental factors as pH, temperature, and dissolved oxygen (DO) concentrations. Since the nitrifiers are autotrophic, inorganic carbon sources (such as carbon dioxide, carbonates, and bicarbonate) have a large influence on microbial growth rates.(119)

Aerobic nitrifiers require relatively large quantities of molecular oxygen to complete the oxidation of ammonia. The theoretical oxygen requirements, based on the biochemical equations of nitrification, were determined to be 4.57 kg of O_2 required/kg of ammonia nitrified (4.57 lb of O_2 required/lb of ammonia nitrified). Generally, this oxygen demand may be satisfied by atmospheric molecular oxygen furnished through conventional aeration techniques. However, since the nitrifiers are autotrophic and obtain their carbon requirements from such compounds as carbon dioxide and bicarbonates, the oxygen contained in these compounds may also be available for metabolism. Thus, depending on the alkalinity of the wastewater, the actual oxygen which must be furnished by aeration equipment may be lower than the theoretical 4.57 ratio. Discounting the ammonia required for BOD_5 removal, the nitrifiers will also utilize a fraction of the available nitrogen for synthesis of cellular components. This ammonia demand is estimated to be equivalent to 0.7 to 0.9 oxygen equivalents; therefore, the theoretical oxygen ratio of 4.57 would be reduced to about 3.9 kg of O_2/kg of ammonia nitrified (3.9 lb of O_2/lb of ammonia nitrified).(120)

Since the nitrifiers have slower growth rates, a biological system designed for nitrification requires a longer detention time and longer sludge age. Insufficient nitrification will result unless the sludge wastage rate is lowered to accommodate the nitrifier requirements. Therefore, the wastage rate is usually controlled to maintain a sufficient sludge age in the system to accomplish nitrification. Published data for municipal wastes indicate that a sludge age greater than four days in the activated sludge process is adequate for 90 percent nitrification at 20°C (68°F).(120) Laboratory experiments conducted on pulp and paper wastewaters (weak black liquor) with influent ammonia and BOD_5 concentrations of 264 mg/l and 511 mg/l indicate that a sludge age of approximately 14 days is required for conversion of 90 percent of the ammonia to nitrate. (119)

In the absence of severe inhibitors, a single-stage activated sludge system can be properly designed to achieve BOD_5 removal and nitrification in a single aeration basin. Available literature indicates that 90 percent ammonia removal can be achieved through nitrification provided that proper operating conditions are maintained.(100)(117)(121)(122)(123)(124)(125) In low strength wastes, ammonia removal to levels of less than 10 mg/l is achieveable depending on the variability of the influent ammonia concentration. (120)

The sensitivity of the nitrification process to environmental conditions is well documented in the literature previously cited. Temperature, pH, and dissolved oxygen levels are parameters having interrelated effects on the nitrification process. This sensitivity and the difficulty in maintaining optimum environmental conditions can be overcome through treatment system design and operation. To offset the decrease in the nitrification rate that can occur if optimum conditions are not maintained, longer aeration basin detention time and longer sludge ages can be employed and maintained. Additionally, provisions can be made to (a) neutralize the effluent to maintain a proper pH, and (b) heat or cool the effluent and/or cover the aeration basins to maintain proper temperature.

Chemically Assisted Clarification

Dissolved and colloidal particles in treated effluents are not readily removed by simple settling. Colloidal particles can be agglomerated by the addition of chemical coagulants. Coagulants in common use include lime, alum, ferric chloride, ferric sulfate, and magnesia. Detailed discussions of the chemistry of coagulants are available.(126)

Rebhun et al. suggest that the most efficient method of pulp and paper mill effluent flocculation is a solids-contact type clarifier.(127) Ives suggests a theory for the operation of solids-contact clarifiers that considers their integrated role as flocculators, fluidized beds, and phase separators.(128) Ives states that the criterion for good performance is the dimensionless product of velocity gradient, time, and floc concentration. He also suggests that model floc blanket studies can be meaningful for full-scale operation provided that the concentration of floc in the blanket and the blanket depth are the same in both model and prototype.(128)

Ives also suggests a number of design considerations for solids-contact clarifiers. For floc particles to form a blanket in a circular tank, the upflow velocity of the water must be equal to the hindered settling velocity of floc suspension. It is important that the floc removed from the blanket balance the rate of floc formation. The clarifier should be symmetrical; the inlet flow should be uniformly dispersed and the collection at the outlet should also be uniform. The clear water zone should have a minimum depth equal to half the spacing between collection troughs.

Upon floc formation, settling is accomplished in a quiescent zone. The clarification process results in waste solids that must be collected, dewatered, and disposed. The quantity, settleability, and dewaterablity of the waste solids depend largely on the coagulant employed. In some cases the coagulant can be recovered from the waste solids and reused.

Case studies of full, pilot, and laboratory-scale chemical clarification systems are discussed in the following sections.

Case Studies-Full Scale Systems. Several full-scale, chemically assisted clarification systems have been constructed in the pulp, paper, and paperboard industry and in other industrial point source categories. Data on the capability of full-scale systems to remove conventional and nonconventional pollutants are presented below.

Conventional Pollutants - Recent experience with full-scale alum-assisted clarification of biologically-treated kraft mill effluent suggests that final effluent levels of 15 mg/l each of BOD_5 and TSS can be achieved. The desired alum dosage to attain these levels can be expected to vary depending on the chemistry of the wastewater to be treated. The optimum chemical dosage is dependent on pH.

Chemical clarification following activated sludge is currently being employed at a groundwood (chemi-mechanical) mill. According to data provided by mill personnel, alum is added at a dosage of about 150 mg/l to bring the pH to an optimum level of 6.1. Polyelectrolyte is also added at a rate of 0.9 to 1.0 mg/l to improve flocculation. Neutralization using NaOH is practiced prior to final discharge to bring the pH within acceptable discharge limits. The chemical/biological solids are recycled through the activated sludge system with no observed adverse effects on biological organisms. Average reported results for 12 months of sampling data (as supplied by mill personnel) show a raw wastewater to final effluent BOD_5 reduction of 426 mg/l to 12 mg/l and TSS reduction of 186 mg/l to 12 mg/l.

Treatment system performance at the mill was evaluated as part of a study conducted for the EPA.(129) Data obtained over 22 months shows average final effluent BOD_5 and TSS concentrations of 13 and 11 mg/l, respectively. As part of this study, four full-scale chemically assisted clarification systems in other industries were evaluated. Alum coagulation at a canned soup and juice plant reduced final effluent BOD_5 concentrations from 20 mg/l to 11 mg/l and TSS levels from 65 mg/l to 22 mg/l. Twenty-five mg/l of alum plus 0.5 mg/l of polyelectrolyte were added to the biologically-treated wastewater to achieve these final effluent levels. Treatment plant performance was evaluated at a winery where biological treatment followed by chemically assisted clarification was installed. Final effluent levels of 39.6 mg/l BOD_5 and 15.2 mg/l TSS from a raw wastewater of 2,368 mg/l BOD_5 and 4,069 mg/l TSS were achieved. The influent wastewater concentrations to the clarification process were not reported. The chemical dosage was 10 to 15 mg/l of polymer.(129) A detailed summary of the results of the study of full-scale systems is presented in Table VII-9.(129)

In October of 1979, operation of a full-scale chemically assisted clarification system treating effluent from an aerated stabilization basin at a Northeast bleached kraft mill began. This plant was designed and constructed after extensive pilot-scale studies were completed. The purpose of operating the pilot plant was to demonstrate that proposed water quality limitations could be met through the use of chemically assisted clarification. After demonstrating that it was possible to meet the proposed levels, studies were conducted to optimize chemical dosages. The testing conducted showed that the alum dosage could be reduced significantly by the addition of acid for pH control, while still attaining substantial TSS removal. In the pilot-scale study, it was shown that total alkalinity, a measure of a system's buffering capacity, was a reliable indication of wastewater variations and treatability. Through this study, it was shown that there is a direct relationship between total alkalinity and alum demand. High alkalinity (up to 500

TABLE VII-9

SUMMARY OF CHEMICALLY ASSISTED CLARIFICATION TECHNOLOGY PERFORMANCE DATA

Major Industrial Category	Industrial Plant & Location	Subcategory or Products	Description of Biological Treatment	Average of Period - Clarifier Influent BOD5	Average of Period - Clarifier Influent TSS	Average of Period - Clarifier Effluent BOD5	Average of Period - Clarifier Effluent TSS	Maximum Day Clarifier Effluent BOD5	Maximum Day Clarifier Effluent TSS	Maximum 30 Consecutive Day Average Clarifier Effluent BOD5	Maximum 30 Consecutive Day Average Clarifier Effluent TSS	Percent Removals Across Clarifier BOD5	Percent Removals Across Clarifier TSS	Surface Overflow Rates and Detention Time	Chemicals Added and Dosage Rate Average	NPDES Permit Average Maximum Day BOD5	NPDES Permit Average Maximum Day TSS	Average of Period Plant Influent Flow	Average of Period Plant Influent BOD5	Average of Period Plant Influent TSS
Pulp and Paper	[illegible]	[illegible]	Aerated Stabilization Basin [illegible] lb BOD5/1000 cu ft./D Hydraulic detention time - 8 days at 2.25 MGD Nitrogen & phosphorus added	average of 12 months of daily data N.D.	average of 12 months of daily data 1395.7 lb/day	average of 12 months of daily data 160.7 lb/day	average of 12 months of daily data 172.8 lb/day	506.4 lb/day	1502.6 lb/day	Based on 12 months of daily data 201.1 lb/day	Based on 12 months of daily data 250.5 lb/day	Based on annual average Based on mean of 30 consecutive day averages N.D.	87%	For annual ave. flow of 1.6 MGD 369 gal/day/sq.ft. For max.day flow of 2.8 -641 gal/day/sq.ft.	Alum - Silica -	30 Day average 275 lb/D UNDER NPDES NO. 1 July '75	30 Day average 400 lb/D No. 74-69 CA0004821 effective	MGD 1.95 average of 12 months of daily data	<5.7 mg/l average of 12 months of daily data	1.6 lbs/1000 gal average of 12 months of daily data
				average of 10 months of daily data 305.5 lb/day	average of 10 months of daily data 737.7 lb/day	average of 10 months of daily data 140.2 lb/day	average of 10 months of daily data 177.2 lb/day	673.3 lb/day	1400.2 lb/day	Based on 10 months of daily data 239.7 lb/day	Based on 10 months of daily data 257.9 lb/day	Based on annual average (10 months) 29% Based on mean of 30 consecutive day averages 35%	76% 76%	For annual average flow of 1.9 MGD - 432 gal/day/sq.ft. For max.day flow of 2.5 MGD - 566 gal/sq.ft.	Alum - 150 mg/l average Polymer 0.5 mg/l average	Average flow of 2.2 mgd. Max. day 550 lb/D 30 mg/l	Max. Day 800 lb/D 60 mg/l	1.9 MGD Average of 10 months of daily data	N.D.	1.7 lbs/1000 gal Average of 10 months of daily data
[illegible]	[illegible]	[illegible]	Activated sludge (extended aeration) F/M - 0.05 to 0.1 lb BOD5 applied/lb MLSS MLSS - 2000-2500 mg/l Hydraulic detention time 30 hours at 2 MGD Nitrogen & phosphorus added	Data not provided		Average of 4 quarterly averages with chemicals 333.3 lb/D	Average of 4 quarterly averages with chemicals 303.8 lb/D	Data not provided		Data not provided.		Data not available for calculations		For average period flow - 2.097 MGD 220 gal/D/sq.ft. 7 hours detention	Polymer only cationic 0-10 mg/l Average 8 mg/l	Daily average 750 lb/D NPDES NO. NC0000663 31 Dec. 73 to 31 Dec. 76 Ave. flow 2.5 MGD	Daily average 1040 lb/D	Data not provided.		
[illegible]				Data not provided		Average of 4 quarterly averages without chemicals 151 lb/D	Average of 4 quarterly averages without chemicals 665.3 lb/D	Data not provided.		Data not provided.		Data not available for calculations		For average period flow - 1.67 MGD 176 gal/D/sq.ft. 7 hours detention	None added	Daily maximum 100 lb/D	Daily maximum 2000 lb/D	Data not provided.		
[illegible]	[illegible]	[illegible]	2 stage trickling filter followed by aerated lagoon with 5 days detention with sub-surface static aeration 18" diameter x 12 feet long.	Annual average June '75 to May '76 30 mg/l No back up data provided	Annual average June '75 to May '76 65 mg/l No back up data provided	Figures provided without back up data 11 mg/l Annual average June '75 to May '76	22 mg/l Annual average June '75 to May '76	Data not provided		Data not provided.		No back up data provided for calculation		558 gal/day/sq. ft. @ 4.3 MGD = 3.5 hours detention time	Campbell soup had no record of when chemicals were added or not added Alum can be added at lagoon effluent weir @ 25 mg/l Polymer added at flow splitting box before clarifiers 0.5 mg/l	Daily average - 45 mg/l TSS Daily maximum - 90 mg/l TSS Daily average - 30 mg/l BOD5 Daily maximum - 75 mg/l BOD5 MD 0221 *AD		4.3 MGD average Number provided, no back-up data provided	471 mg/l average Number provided, no back-up data provided	364 mg/l average Number provided, no back-up data provided
Wine [illegible]	[illegible]	Wine	Activated sludge 19.6 lb BOD/1000 cu.ft. F/M = 0.07 MLSS = 4000 Detention Time = 8 days 0.170 MGD Phosphorus and nitrogen added	Average of period from April 26, 1976 to July 31, 1976 7360 mg/l	Average of period from April 26, 1976 to July 31, 1976 4000 mg/l	Average of period from April 26, 1976 to July 31, 1976 39.6 mg/l	15.2 mg/l Data after post aeration and chlorination	Data after post aeration and chlorination 70 mg/l for period April 26, 1976 to July 31, 1976	36 mg/l	Data not available		Average of period from April 26, 1976 to July 31, 1976 N/A	99.6%	At average flow 0.17 MGD 160 gal/D sq.ft. 11.5 hours	Polymer at 10-15 mg/l Testing period for proper dosage	Process Season - Daily average - 30 mg/l - BOD5 Daily maximum - 50 mg/l - BOD5 Daily average - 20 mg/l - TSS Daily maximum - 50 mg/l TSS		0.177 MGD Average of period April 26, 1976 to July 31, 1976 Caution - does not include the pressing season which is the season of highest loading	2368 mg/l	215.5 mg/l

* [illegible]

mg/l) caused by the discharge of black liquor or lime mud results in high alum demands. Therefore, a substantial portion of alum dosage can be used as an expensive and ineffective means of reducing alkalinity (pH) to the effective pH point (5-6) for optimum coagulation. The use of acid to assist in pH optimization can mean substantial cost savings and reduction in the alum dosage rate required to effect coagulation. In one instance, use of concentrated sulfuric acid for pH reduction reduced alum demand by 45 percent. Acid addition was also effective in reducing alum dosage for wastewaters with a low alkalinity (approximately 175 mg/l).(130) Table VII-10 summarizes effluent quality of the full-scale system since startup; this system has been operated at an approximate alum dosage rate of 350 mg/l without acid addition. Recent correspondence with a mill representative indicated that, with acid addition, this dosage rate could be reduced to 150 mg/l.(131) However, this lower dosage rate has not been confirmed by long-term operation.

A chemically assisted clarification system treating effluent from an aerated stabliization basin at a southeastern U.S. deink-newsprint mill began operation in 1979. Typical alum dosage rates are 450 mg/l; polymer is also added at a rate of 1 to 1.5 mg/l. Caustic is added to maintain final effluent pH within permitted levels. Table VII-11 summarizes available effluent data for this facility subsequent to treatment system start-up and stabilization.

Amberg, et al. (132) reported on a cellulose mill located on the shore of Lake Baikal in the USSR. The mill produced 200,000 kkg (220,000 tons) of tire cord cellulose and 11,000 kkg (12,100 tons) of kraft pulp per year. Average water usage was 1,000 kl/kkg (240 kgal/t). The mill had strong and weak wastewater collection and treatment systems. The average BOD$_5$ for the weak wastewater system was 100 mg/l, while the strong wastewater BOD$_5$ was 400 mg/l. Only 20 percent of the total wastewater flow was included in the strong wastewater system. Each stream received preliminary treatment consisting of neutralization to pH 7.0, nutrient addition, and aerated equalization. Effluent from equalization was discharged to separate aeration and clarification basins. These basins provided biological treatment using a conventional activated sludge operation. Aeration was followed by secondary clarification. Suspended solids were settled and 50 percent of the sludge was returned to the aeration process. Waste sludge was discharged to lagoons. The separate streams were combined after clarification and were treated for color and suspended solids removal in reactor clarifiers with 250 to 300 mg/l of alum and 1 to 2 mg/l of polyacrylamide flocculant, a nonionic polymer. The clarifiers had an overflow rate of approximately 20.4 cu m per day/sq m (500 gpd/sq ft).

Chemical clarification overflow was discharged to a sand filtration system. The sand beds were 2.9 m (9.6 ft) deep with the media arranged in five layers.(133) The sand size varied from 1.3 mm (0.05 in) at the top to 33 mm (1.3 in) at the bottom. The filter was loaded at 0.11 cu m per minute/sq m (2.7 gpm/sq ft). Effluent from sand filtration flowed to a settling basin and then to an aeration basin;

TABLE VII-10

FINAL EFFLUENT QUALITY OF A CHEMICALLY ASSISTED CLARIFICATION SYSTEM TREATING BLEACHED KRAFT WASTEWATER

Date	BOD5 (mg/l) Average for Month	BOD5 (mg/l) Maximum Day	TSS (mg/l) Average for Month	TSS (mg/l) Maximum Day
September 1979	11	21	87	254
October 1979	8	12	40	92
November 1979	9	18	28	47
December 1979	21	83	21	56
January 1980	8	16	28	36
February 1980	7	14	31	68
March 1980	13	46	44	113
April 1980	9	16	32	96
May 1980	11	22	38	80
June 1980	25	49	39	65
July 1980	5	9	22	50
August 1980	10	21	40	84
September 1980	13	25	40	72
October 1980	11	28	34	75
November 1980	20	44	60	107
December 1980	33	93	50	139
January 1981	17	--	30	43
February 1981	17	43	47	82
March 1981	29	53	49	93

TABLE VII-11

FINAL EFFLUENT QUALITY OF A CHEMICALLY ASSISTED CLARIFICATION SYSTEM TREATING WASTEWATER FROM A DEINK-NEWSPRINT MILL

Date	BOD5 (mg/l)		TSS (mg/l)	
	Average for Month	Maximum Day	Average for Month	Maximum Day
January 1980	39	88	18	45
February 1980	28	59	18	48
March 1980	25	46	16	43
April 1980	17	33	19	45
May 1980	20	53	20	53
June 1980	30	56	28	76
July 1980	22	44	13	35
August 1980	21	35	18	46
September 1980	16	35	21	109
October 1980	14	22	15	28
November 1980	15	32	15	105
December 1980	23	37	23	69
January 1981	50	92	32	84
February 1981	38	45	21	50
March 1981	25	51	14	56

both basins were operated in series and provided a seven hour detention time.

The effluent quality attained was as follows:

Parameter	Raw Waste	Final Effluent
BOD$_5$ (mg/l)	300	2
Suspended Solids (mg/l)	60	5
pH	-	6.8 - 7.0

Individual treatment units were not monitored for specific pollutant parameters.

Nonconventional Pollutants. The development of coagulation processes for color removal has been traced by many investigators. Investigators concluded that lime precipitation was a coagulation process for color removal which afforded the possibility of chemical recovery utilizing existing mill equipment. Based on the results of this early work, research continued towards development of a lime precipitation process. The overriding problem in this work continued to be the difficulty of dewatering the lime-organic sludge. Specific studies were conducted for resolving the sludge problem with limited success.(134)(135)

Continuing efforts to improve the dewatering of the lime sludge led to consideration of using large dosages of lime for color reduction. It was believed that a large quantity of rapidly draining materials would reduce the effect of the organic matter on dewatering. This thinking led to the development and patenting of the "massive lime" process by the National Council for Air and Stream Improvement. In this process, the mill's total process lime is slaked and reacted with a highly colored effluent stream, usually the caustic extraction effluent. The lime sludge is then settled, dewatered, and used for causticizing green liquor. During the causticizing process, the color bodies are dissolved in the white liquor and eventually burned in the recovery furnace. Although the massive lime process had been demonstrated as an effective color removal system, the process was not taken beyond the pilot stage for several years.

The first installation of the massive lime color system was operated at a mill in Springhill, Louisiana. The 33.4 liter per sec (530 gpm) demonstration plant was used to treat the bleach plant caustic extraction and unbleached stock decker wastewaters. These streams contributed 60 to 75 percent of total mill color. In the process, the lime slurry dosage was 20,000 mg/l.

The demonstration plant at Springhill was first tested using 100 percent bleach plant caustic extraction effluent. Various amounts of unbleached decker effluent were then added until 100 percent decker effluent was treated. Color removal ranged from 90 to 97 percent with an average of 94 to 95 percent (136). Organic carbon removal ranged from 55 to 75 percent and generally increased with higher colored effluent. The values reported are shown in Table VII-12. BOD_5 removals of 25 to 45 percent were reported with lower values found during treatment of most highly-colored effluent. The net effect of the treatment process was estimated as a 72 percent reduction of total mill color.

The massive lime process, as developed, required lime dosages of approximately 20,000 mg/l. Because of this, only a relatively small effluent stream could be treated with the quantity of lime used for causticizing green liquor. Additionally, this process required modifications to the recovery system. These restrictions led to the development of an alternative process employing "minimum lime" treatment. Lime dosages of 1,000 to 2,000 mg/l are common to this process.(137)(138) A previous EPA document reported data on full-scale minimum lime treatment systems.(47) Two systems treating unbleached kraft and NSSC effluents are known to be operating. Color levels of 1,200 to 2,000 color units are reported to be 80 to 90 percent removed with lime dosages of 1,000 to 1,500 mg/l. A full-scale system treating the first caustic extract of a bleached kraft mill has been shut down. When operating, lime dosages of 1,500 to 3,000 mg/l were used to remove 90 percent of a color load that ranged from 8,000 to 10,000 color units.(47)

Case Studies-Pilot and Laboratory Scale Systems. Several laboratory and pilot-scale studies of the application of chemically assisted clarification to treat pulp, paper, and paperboard wastewaters have been conducted. Available data on the capability of this technology to remove conventional and nonconventional pollutants based on laboratory and pilot-scale studies are presented below.

Conventional Pollutants - As part of a study of various solids reduction techniques, Great Southern Paper Co. supported a pilot-scale study of chemically assisted clarification.(139) Great Southern operates an integrated unbleached kraft mill. Treatment consisted of primary clarification and aerated stabilization followed by a holding pond. The average suspended solids in the discharge from the holding pond were 65 mg/l for the period January 1, 1973 to December 31, 1974. In tests on this wastewater, 70 to 100 mg/l of alum at a pH of 4.5 provided optimum coagulation. Three alum dosages were tested. At the optimum dosages, the removals after 24 hours of settling ranged from 83 to 86 percent. Influent TSS of the sample tested was 78 mg/l. Effluent TSS concentrations ranged from 11 to 13 mg/l.

In a recent EPA-sponsored laboratory study, alum, ferric chloride, and lime in combination with five polymers were evaluated in further treatment of biological effluents from four pulp and paper mills.(140) Of the three chemical coagulants, it was reported that alum provided the most consistent flocculation at minimum dosages, while lime was the least effective of the three. However, the study provides inconclusive results in determining the optimum chemical to be used or the optimum chemical dosage for removal of TSS from biologically-treated effluents. These inconclusive findings are the result of a number of factors, including (a) the lack of determination

TABLE VII-12

COLOR AND ORGANIC CARBON REMOVAL AFTER APPLICATION OF MASSIVE LIME TREATMENT[1]

Composition of Treated Effluent		Effluent Color (APHA Color Units)		Color Removal (%)	Organic Carbon (mg/l)		Organic Carbon Removal (%)
Bleach Plant Caustic Extraction Stage Effluent (%)	Kraft Decker Effluent (%)	Before Treatment	After Treatment		Before Treatment	After Treatment	
100	0	21,546	1,265	94.2	1,446	373	74.2
67	33	14,325	745	94.8	1,016	253	75.1
60	40	12,125	594	95.1	905	248	72.6
50	50	10,043	451	95.5	798	245	69.3
33	67	6,612	331	95.0	569	183	67.8
20	80	4,660	298	93.6	450	173	61.6
0	100[1]	1,640(a)	140(a)	91.5(a)	270(a)	120(a)	55.6(a)
0	100[2]	900(b)	234(b)	74.0(b)	268(b)	126(b)	53.0(b)

(a) Very little paper mill white water reuse for decker pulp washing or as make-up water.

(b) Practically all water used in decker system was white water from paper mill.

[1] Oswalt, J.L., and J.G. Land Jr., Color Removal from Kraft Pulp Mill Effluents by Massive Lime Treatment. EPA Project 12040 DYD, 1973.(136)

of an optimum pH to effect removal of TSS, (b) the lack of consideration of higher chemical dosages when performing laboratory tests even though data for some mills indicated that better removal of TSS was possible with higher chemical dosage (a dosage of 240 mg/l was the maximum considered for alum and ferric chloride, while 200 mg/l was the maximum dosage used for lime), (c) the testing of effluent from one mill where the TSS concentration was 4 mg/l prior to the addition of chemicals, and (d) the elimination of data based simply on a visual determination of proper flocculation characteristics.

Laboratory data on alum dosage rates for chemically assisted clarification were submitted to the Agency in comments on the contractor's draft report.(141) Data submitted for bleached and unbleached kraft wastewaters indicate that significant removals of suspended solids occur at alum dosages in the range of 100 to 350 mg/l.(142)(143)(144) For wastewaters discharged in the manufacture of dissolving sulfite pulp, effluent BOD_5 and TSS data were submitted for dosage rates of 250 mg/l; however, it was stated that dosages required to achieve effluent TSS concentrations on the order of 15 mg/l would be in the range of 250 to 500 mg/l.(145) Subsequent to the comment period, the NCASI assembled jar test data for several process types and submitted the data to the Agency.(146) Data for chemical pulping subcategories indicate that alum dosages in the range of 100 to 700 mg/l will effect significant removals of TSS. The average dosage rate for all chemical pulping wastewaters was 282 mg/l. Data submitted for the groundwood, deink, and nonintegrated-fine papers subcategories indicate that dosages in the range of 100 to 200 mg/l will significantly reduce effluent TSS.

Toxic and Nonconventional Pollutants - As part of an EPA-sponsored study, biologically-treated effluent from a kraft mill was further treated using alum precipitation technology on a laboratory-scale.(90) Existing full-scale treatment at the mill consisted of a primary clarifier, an aerated stabilization basin, and a polishing pond. Twenty-four hour composite samples of the polishing pond effluent were taken on three separate days. The samples were adjusted to a pH of 4.6 with alum; four drops of polymer per liter of sample were added. The results are summarized below:

	Polishing Pond Effluent Range (mg/l)	Alum-Treated Effluent Range (mg/l)
Total Resin and Fatty Acids	2.82 - 3.75	Undetected
Total Chlorinated Derivatives	0.43 - 0.45	Undetected - 0.04
Chloroform	0.025 - 0.032	0.018 - 0.022
BOD_5	43.0 - 51.0	0 - 14.0

Other researchers have investigated modifications of chemically assisted clarification technology using lime. This research has concentrated primarily on color removal. Investigations have included the use of alternative coagulants in combination with lime. Olthof and Eckenfelder reported on the use of ferric sulfate, lime, and alum to reduce effluent color at two bleached kraft mills and one unbleached kraft paperboard mill.(147)(148) Their results, as shown in Table VII-13, provide both an optimum pH and optimum dosage for each case. All three coagulants were able to achieve a reduction in color from 1,000 to 3,000 platinum-cobalt (Pt-Co) units to 125 to 300 Pt-Co units. Note that the dosage required for color reduction is higher than that generally applied for BOD_5 and TSS reduction only.

Olthof and Eckenfelder concluded that ferric sulfate used for color removal of pulp, paper, and paperboard mill wastewaters can be an attractive alternative to lime treatment. This conclusion was drawn from the fact that the required optimum dosage of ferric sulfate was 25 to 33 percent that of the optimum lime dosage. In addition, the effluent quality which results from use of ferric sulfate was better than that resulting from lime. Lime treatment results in a high pH and a great deal of calcium in solution. Common practice is to use an additional treatment step, recarbonation, which reduces the pH prior to biological treatment and allows for recovery of calcium as $CaCO_3$. The use of ferric sulfate and alum prior to biological treatment does not require recarbonation and may not require neutralization. Berov studied the need for neutralization of kraft mill effluents which were treated with alum for color removal.(149) He concluded that if the chemically treated process effluent pH did not fall below 5.8, neutralization was not needed prior to biological treatment.

Dugal, et al. performed laboratory studies on color reduction with a combined ferric chloride and lime treatment system.(150) This study sought to establish conditions for improving the lime treatment systems by using multivalent ions with the lime for color precipitation. Earlier investigations of the lime precipitation treatment system removal demonstrated 85 to 90 percent removal of color; it was determined that the remaining color bodies had an apparent average molecular weight of less than 400. Preliminary studies with multivalent ions and lime showed almost total color removal.

Tests were run in the laboratory on the decker filtrate and caustic extraction discharge from International Paper Company's mill at Springhill, Louisiana. Various salts such as barium chloride, ferric chloride, magnesium hydroxide, and zinc chloride were used in the initial experiments. Based on data from these initial experiments, ferric chloride was selected for further analysis. In general, it was determined that trivalent ions are more effective color-removing agents than divalent ions. Table VII-14 presents a summary of the results.(150)

Twenty-four experiments were run using ferric chloride and/or lime at various concentrations. Color removal up to 98.7 percent was attained and it was concluded that a synergistic effect between lime and ferric chloride existed. Table VII-15 shows the results of these 24 experiments.(150)

TABLE VII-13

COLOR REDUCTIONS ACHIEVED AFTER APPLICATION OF CHEMICALLY ASSISTED CLARIFICATION WITH FERRIC SULFATE, ALUM, AND LIME[1]

	Ferric Sulfate				Alum				Lime			
Mill Type	Optimum Dosage (mg/l)	Color Reduction (%)	Final Color Value (Pt-Co.Units[2])	Optimum pH	Optimum Dosage (mg/l)	Color Reduction (%)	Final Color Value (Pt-Co.Units[2])	Optimum pH	Optimum Dosage (mg/l)	Color Reduction (%)	Final Color Value (Pt-Co.Units[2])	Optimum pH
Bleached Kraft	500	92	250	3.5-4.5	400	92	200	4-5	1,500	92	300	12.-12.5
Bleached Kraft	275	91	125	3.5-4.5	250	93	100	4-5	1,000	85	200	12.-12.5
Unbleached Kraft Paperboard	250	95	150	4.5-5.5	250	91	100	5-6	1,000	85	150	12.-12.5

---

[1] Sources: Olthof, M.G., "Color Removal From Textile and Pulp and Paper Wastewaters by Coagulation," Vanderbilt University, PhD Thesis, 1974.(147)
Olthof, M.G. and Eckenfelder, W.W., Jr., "Laboratory Study of Color Removal from Pulp and Paper Wasewaters by Coagulation," TAPPI, Vol. 57, No. 8, August 1974.(148)

[2] Platinum-Cobalt Units

TABLE VII-14

COMPARISON OF TREATMENT EFFICIENCIES ON KRAFT EFFLUENTS BY THE APPLICATION OF CHEMICALLY ASSISTED CLARIFICATION USING DIVALENT IONS OR TRIVALENT IONS[1]

Salt Concentration (mg/l)	Decker Filtrate		Caustic Extract		Salt Concentration (mg/l)	Decker Filtrate		Caustic Extract	
	Final pH	Color Removal (%)	Final pH	Color Removal (%)		Final pH	Color Removal (%)	Final pH	Color Removal (%)
$Mg(OH)_2$					Alum [$Al_2(SO_4)_3$ $18H_2O$]				
0	7.2	--	8.2	--	0	7.2	--	7.9	--
100	7.4	0	8.4	0	100	7.3	59.1	6.5	7.7
200	7.5	2.5	8.7	6.8	200	5.1	87.1	4.8	63.1
250	7.8	5.0	8.9	11.4	250	4.7	90.9	4.4	85.2
300	8.0	2.5	9.0	11.4	300	4.6	88.1	4.3	84.6
350	8.0	2.5	9.0	11.4	350	4.5	88.2	4.2	85.2
400	8.1	7.5	9.1	12.0	400	4.5	88.2	4.3	84.6
600	8.0	7.5	9.2	22.8	600	4.5	86.8	4.1	86.5
$ZnCl_2$					$FeCl_3$-pH unadjusted				
0	7.2	--	8.1	--	0	7.2	--	6.7	--
100	6.9	2.5	6.9	0	100	5.8	27.3	6.1	0
200	6.5	5.0	6.7	3.9	200	5.0	75.5	5.6	24.4
250	6.5	7.5	6.7	3.9	250	4.1	76.4	5.1	26.9
300	6.4	12.5	6.7	13.6	300	3.8	77.3	4.8	51.3
350	6.3	17.5(a)	6.7	13.4	350	3.7	77.3	4.4	74.8
400	6.2	22.5	6.7	22.9	400	3.4	75.5	4.1	91.7
600	6.0	45.4	6.7	44.0	600	3.1	76.4	3.8	90.7
$BaCl_2$					$FeCl_3$-pH adjusted				
0	7.2	--	7.1	--	0	7.2	--	6.7	--
100	7.3	5.0	6.9	0	100	8.2	0	8.4	0.6
200	7.2	16.7	6.5	0	200	8.7	21.1	8.9	67.4
250	7.1	21.7	6.5	0	250	8.3	12.6	8.7	83.1
300	7.0	23.3	6.6	1.3	300	8.5	38.9	9.1	97.2
350	6.9	26.7	6.8	4.1	350	8.9	58.3	8.6	97.3
400	6.7	28.3	6.9	1.1	400	8.9	50.9	8.1	97.3
600	6.4	41.2	7.0	23.7	600	8.8	72.5	7.8	97.4
800	6.2	42.5	7.1	35.9					
1000	5.7	61.2	7.1	45.2					
$Ca(OH)_2$									
0	--	--	8.6	--					
100	--	--	10.3	20.0					
200	--	--	11.3	22.5					
250	--	--	11.6	22.5					
300	--	--	11.7	25.0					
350	--	--	11.8	32.5					
400	--	--	11.9	62.5					
600	--	--	12.1	72.5					

(a) Calculated Value.

---

[1] Source: Dugal, H.S., Church, J.O., Leekley, R.M., and Swanson, J.W., "Color Removal in a Ferric Chloride-Lime System," TAPPI, Vol. 59, No. 9, September 1976.(150)

TABLE VII-15

LIME TREATMENT OF BLEACHED KRAFT CAUSTIC EXTRACT IN THE PRESENCE OF METAL ION[1](a)

$FeCl_3$ (mg/l)	Lime (mg/l)	Sludge Volume(b) (ml)	Final pH	Color Removal (%)	TOC Removal (%)	BOD Removal (%)
0	1000	6.2	11.58	81.4	66.6	6.5
25	1000	8.2	11.50	81.7	66.0	4.3
50	1000	8.2	11.42	85.7	71.0	0.0
100	1000	8.5	11.42	90.0	78.0	12.8
200	1000	13.3	11.49	91.4	76.4	23.5
300	1000	14.4	11.50	91.6	74.3	27.7
500	1000	22.0	11.40	95.8	81.0	36.2
800	1000	30.1	11.32	95.5	83.2	40.5
0	2000	6.2	11.79	87.2	68.6	23.5
25	2000	7.0	11.70	88.0	75.4	23.5
50	2000	7.3	11.70	89.5	73.0	25.5
100	2000	9.7	11.70	91.8	75.2	29.8
200	2000	14.1	11.70	93.6	79.6	34.0
300	2000	19.1	11.71	95.2	81.6	36.2
500	2000	33.5	11.78	96.8	86.0	44.7
800	2000	62.0	11.73	97.5	87.3	51.0
0	18,000	8.9	11.98	93.4	80.4	32.0
25	18,000	8.7	11.99	94.9	79.5	32.0
50	18,000	9.0	11.98	95.0	77.6	38.4
100	18,000	9.4	12.00	95.9	81.7	36.2
200	18,000	11.2	12.01	96.3	84.0	36.2
300	18,000	12.2	12.01	97.3	81.5	46.8
500	18,000	14.3	12.01	98.2	87.7	46.8
800	18,000	16.8	12.00	98.7	88.7	51.0

(a)Untreated caustic extract had a pH of 8.83, a color of 4400 units, a TOC of 220 mg/liter, and a BOD of 47 mg/liter.

(b)Total volume of kraft bleach caustic extract after lime and $FeCl_3$ addition was 100 ml. Sludge volumes were measured after a 15-minute settling time.

---

[1]Source: Dugal, H.S., Church, J.O., Leekley, R.M. and Swanson, J.W., "Color Removal in a Ferric Chloride-Lime System," TAPPI, Vol. 59, No. 9, September 1976.(150)

Another flocculation and precipitation process is in full-scale operation in Japan; it has also been investigated through laboratory studies in Sweden. The process involves using iron salts and lime to obtain color removals in the range of 85 to 95 percent.(151) Chlorination and caustic extraction stage effluents are treated. Metallic iron is first dissolved in the chlorination stage effluent. Retention times of 1.5 to 2 hours and temperatures near 50°C (122°F) are needed to dissolve a sufficient amount of the metallic iron. The resulting solution is then combined with the caustic extract, and the pH is adjusted within the range of 9 to 10 with lime. No chemical dosages were listed for the lime required or the amount of metallic iron consumed.

Vincent studied the decolorization of biologically-treated pulp and paper mill effluents through the addition of lime and lime - magnesia.(152) Laboratory-scale studies were conducted on effluents from three kraft mills, one sulfite mill, and one NSSC mill. All except one of the kraft mill effluents had been treated in a biological system before chemical treatment. Separate testing with lime and magnesia showed that, with the addition of 1,000 mg/l of lime, approximately 90 percent of the color was removed. Magnesia alone proved to be ineffective at moderate doses; 4,000 mg/l were required to obtain approximately 50 percent color reduction. Therefore, it was concluded that the use of magnesia alone could not be justified.

The use of magnesium hydroxide in combination with lime was highly effective. The magnesium was added as a soluble salt prior to the lime slurry. A dosage of 50 to 100 mg/l of magnesia prior to the addition of 500 mg/l of lime gave the same color removal as the addition of 1,000 mg/l of lime alone. Additionally, sludge production was less with the lime - magnesia process. Table VII-16 shows some typical results of the lime - magnesia process for removing color, BOD, COD, and phosphate for the five mills. Recovery techniques were suggested, but none were investigated in connection with this study. This would indicate that additional testing would have to be done to prove the feasibility of this lime - magnesia recovery process before attempting it on a larger scale. An evaluation concluded that the system is costly, but the benefits might favor its use.

Filtration

This process refers to granular bed (rather than membrane) filtration. The granular material may be sand, or coal, diatomaceous earth, and/or garnet in combination with sand. The various media, grain sizes, and bed depths may be varied for optimal results. It is common to vary grain sizes, with the larger sizes at the top of the filter bed, to improve TSS removal and to extend filter run time between backwashings. The addition of a proper chemical flocculant prior to filtration can further improve performance.

Filtration technology was evaluated as part of a study conducted for the EPA.(129) Results obtained during this study of nine pulp, paper,

TABLE VII-16

REMOVAL OF BOD, COD, AND PHOSPHATE FROM CHEMICAL PULPING WASTEWATERS AT SELECTED LIME - MAGNESIA LEVELS[1]

		Treatment		Before Treatment				After Treatment				Removal			
Mill	Effluent	CaO (mg/l)	MgO (mg/l)	Color	BOD(a)	COD(b)	Phosphate(c)	Color	BOD	COD	Phosphate	Color	BOD	COD	Phosphate
A	Kraft (combined effluent, 80% bleached) biological treatment	500	100	2,570	-	420 (560)	1.05	137	16	100	F0.01	94.7	-	76	99.0
B	Kraft (high BOD stream, unbleached) no biological treatment	500	100	1,070	130	340 (560)	0.7	78	105	580 1,310	0.07	92.7	19	-	90.0
C	Kraft (combined effluent) biological treatment	500	100	2,620	60	500 (720)	3.0	185	30	100	0.06	92.9	50	80	98.0
D	Sulfite (NH_3 base, combined effluent) biological treatment	2,000	400	1,790	60	2,430 (1,300)	0.8	298	67	460	0.07	83.4	-	81	91.3
E	NSSC (combined effluent) biological treatment	6,000	3,000	36,300	525	8,640 (4,960)	31.5	12,800	320	1,040	0.80	64.7	39	88	97.5

(a)BOD determined after filtration through Reeve-Angel glass filter papers and subsequent adjustment to pH 7.

(b)COD determined after filtration through Reeve-Angel glass filter papers. Bracketed values are for unfiltered effluents.

(c)Phosphate analysis (values in mg/l of P) determined by modified ascorbic acid method.

---

[1]Source: Vincent, D.L., Colour Removal From Biologically Treated Pulp and Paper Mill Effluents, Distributed by CPAR Secretariat, Canadian Forestry Service, Department of the Environment Ottawa, Ontario, as CPAR Report 210-1, March 31, 1974.(152)

and paperboard and other industrial facilities where filtration was used are shown in Tables VII-17 and VII-18. Also summarized in the tables are the results of pertinent published results from other filtration studies. Table VII-17 summarizes those systems where coagulants were not used prior to filtration, while Table VII-18 addresses those where coagulants were employed.

At those facilities where chemical coagulants were not utilized, final effluent levels of TSS ranging from 5.9 to 35 mg/l were achieved across the filter; TSS reductions ranged from 45 to 79 percent. Those where coagulants were used prior to filtration achieved final effluent TSS levels ranging from 5.0 to 27.5 mg/l with removals of 52 to 85 percent. At the paperboard mill employing single medium sand filtration without chemical addition, an effluent TSS level of 7 mg/l was attained.

Tables VII-19, VII-20, and VII-21 summarize available effluent data for three midwestern mills where paperboard is produced from wastepaper. At these mills, biologically-treated effluent is sand filtered without the use of coagulants. Table VII-19 presents effluent data after treatment in an aerated stabilization basin followed by a three-layer, pressure sand filter. The system was designed to remove 50 percent of the biological solids but, in practice, removes only 30 to 40 percent. Table VII-20 presents effluent data after treatment in an aerated stabilization basin followed by secondary clarification and deep bed sand filtration. Table VII-21 presents effluent data after treatment in an activated sludge system followed by a gravity rapid sand filtration system.

An EPA-sponsored laboratory study evaluated the efficiency of sand filtration of four pulp and paper mill effluents.(140) A flow rate of 0.20 cu m per minute/sq m (5 gpm/ft$\underline{2}$) was used and the results are shown in Table VII-22. As seen, in one of the two cases where coagulation was not employed prior to filtration, substantially better results were obtained than when coagulants were added. It was explained by the authors that natural coagulation, that may have occurred during shipment of samples, could have affected the results.

Activated Carbon Adsorption

Currently, there are two basic approaches for the use of activated carbon: a) use in a tertiary sequence following primary and biological processes and b) use in a "physical-chemical" treatment in which raw wastewater is treated in a primary clarifier with or without chemical coagulants prior to carbon adsorption.

The tertiary approach involves the reduction of biodegradable organics prior to discharge to the carbon system. This provides for longer carbon life. In a physical-chemical treatment mode, biodegradable and refractory organics are removed solely through adsorption on the activated carbon. Activated carbon can achieve high removals of dissolved and colloidal pollutants in water and wastewater. When

TABLE VII-17

TSS REDUCTION CAPABILITIES AND RELATED FACTORS FOR THE FILTRATION TECHNOLOGY WHEN NO CHEMICALS ARE USED

Source of Data	Source of Wastewater	Biological Treatment Process Description	Filter Influent TSS Concentration & Source of Data	Filter Influent TSS Size - Percent < microns*	Hydraulic Loading	Filter Media: No. of Media, Depth, U.S., E.S., Type of Filtration	TSS Filter Effluent	Percent Removal Across Filter, Avg. for Period of Data
A 1	Oil refinery	Activated sludge: F/M - 0.3 MLSS - 1200 mg/l Capacity of 2 basins - ND Detention time - ND Average flow - 4.37 MGD DO min - 1.0 mg/l	10.8 mg/l average of daily data for June 1976	<1.25 - 19.0 <2.5 - 57.0 <5.0 - 89.8	at 4.37 MGD & 3 filters - 3.2 gpm/sq ft	2 media: coal, sand - coal - 18", 0.6 to 0.8 mm sand - 9" 0.4 to 0.5 mm in depth filtration	5.9 mg/l, average of daily data June 1976	TSS - 45%
A 2	Oil refinery	Activated sludge: 10 lb BOD/1000 cu ft, F/M - ND MLSS - ND, DO min - Detention time - 24 hrs @ 1.15 MGD, Mechanical Aeration Average flow - 1.15 MGD	ND	<1.25 - 28.5 <2.5 - 76.3 <5.0 - 89.2	at 1.15 MGD & 3 filters - 2.4 gpm/sq ft	2 media: coal, sand - coal - 24"; UC - ND ES - ND. sand - 12" UC - ND, ES - ND in depth filtration	ND	ND
A 3	Oil refinery	Activated sludge: complete mix, F/M - .02 lb BOD/lb MLVSS, MLSS - 3,500 mg/l DO min - Detention time - 12 hrs @ 23 MGD, Mechanical Aeration Average flow - 19.11 MGD	ND	<1.25 - 53.0 <2.5 - 88.3 <5.0 - 97.5	at 19.11 MGD & 9 filters - 3.5 gpm/sq ft	2 media: coal, sand - coal - 24"; UC - ND ES - ND. sand - 12" UC - ND, ES - ND in depth filtration	11 mg/l, average of 12 monthly averages	ND
A [illegible]	Paperboard products	Activated sludge - complete mix, 20.5 lb BOD/1000 cu ft F/M - .5, MLSS - 3,900 mg/l DO min - Detention time - 12 hrs @ 2 MGD Average flow - 2.0 MGD	ND	<1.25 - 69.3 <2.5 - 91.6 <5.0 - 95.8	at 2.0 MGD & 3 filters - 3.7 gpm/sq ft	1 media: sand sand - 6'0"; ES - 2-3 mm, Sp.Gr. - 2.7	7.0 mg/l, average of 5 monthly averages Feb 76-June 76	ND
A [illegible]	Manmade fiber processing	Activated sludge - 18 lb BOD/1000 cu ft, F/M - MLSS - DO min - Detention time - 48 hrs @ 0.5 MGD Average flow - 2.8 MGD	49.5 mg/l average of 2 monthly averages Does not include old aeration system flow	ND	at 2.83 MGD & 3 filters - 2.15 gpm/sq ft	4 medias. 2 coal, sand, garnet - Coal - 12" Sp.Gr.-1.45 UC & ES - ND Coal - 12" Sp.Gr.-1.5 UC & ES - ND Sand - 9", UC & ES - ND Garnet - 3", UC & ES - ND	16.2 mg/l, average of 2 monthly averages	67%, includes post aeration
Literature Greater Southern Paper Co. Cedar Springs, GA, Pilot study	kraft neutral - sulfite semichemical pulp & paper	Aerated stabilization basin:	average for 3 runs - 68 mg/l	ND	2 gpm/sq ft	ND	average for 3 runs - 35 mg/l	50% Reported by Researchers
Literature Clinton Corn Processing Co. Clinton, IA	food processing	Activated sludge complete mix F/M - MLSS - DO min - Detention time - Average flow -		ND				77%, Nov. 25, 1974 to Feb. 16, 1975
Literature Welch Foods Brockton, NY	grape processing	Activated sludge	season average - 28 mg/l	ND			8.4 mg/l season average	70%, season average
Literature New Brunswick Research & Productivity Council Pilot Plant	pulp mill	Aerated lagoon - lb BOD/1000 cu ft - DO min - Detention time - 12.5 days Total aeration only 8 days Average flow -	40 mg/l grab samples	<5μ - 60% between 5 & 10μ 30%	2.4 to 3.6 gpm/sq ft	3 media - 7" of coarse coal, 3" medium sand - ES - .56, UC - 1.32 5" of coarse sand - ES - 1.42, UC - 1.36	21 mg/l	50%

*Based on one grab sample.

ND = No Data

TABLE VII-18

TSS REDUCTION CAPABILITIES AND RELATED FACTORS FOR THE FILTRATION TECHNOLOGY WHEN CHEMICALS ARE USED

Source of Data	Type of Wastewater	Biological Treatment Process Description	Filter Influent TSS Concentration and Source of Data	Filter Influent TSS Size - Percent <Microns *	Hydraulic Loading Gal. Per Min. Per Square Foot	Filter Media # of Medias, Depth U.C., E.S., Type of Filtration	TSS in Filter Effluent	Percent Removal Across Filter Ave. for Period of Data	Chemicals Added
A-9	Carpet Yarn Dyeing	Activated sludge - extended air 16 lb BOD$_5$/1000 cu. ft. FM - MLSS - 3500-4000 mg/l DO Min - Detention time - 48 hrs. @ 0.5 MGD Average flow - 0.44 MGD	N.D.	1.25μ - 46.4 2.5μ - 78.5 5.0μ - 93.5	at 0.44 MGD and 2 filters 1.9 gpm/sq. ft.	3 Media -coal,sand,garnet Coal - 18" UC - N.D. ES - N.D. Sand - 10" UC - N.D. ES - N.D. Garnet - 9" UC - N.D. ES - N.D.	20.2 mg/l Average of 11 monthly averages	N.D.	Alum - 80-120 mg/l polymer - 1.5 mg/l Added just ahead of secondary clarifier
A-4	Man-made fiber processing	Activated sludge - 18 lb BOD$_5$/1000 cu. ft. F/M - MLSS - DO Min. - Detention time - 76 hrs @ 2.83 MGD Average flow - 2.83 MGD	53.2 mg/l Average of 10 monthly averages - from grab samples Does not include old suction system flow	1.25μ - 29.7 2.5μ - 83.9 5.0μ - 91.1	at 2.83 MGD and 3 filters 2.15 gpm/sq. ft.	4 Media - 2 coal,sand,garnet Coal - 12" Sp Gr - 1.45 UC & ES - N.D. Coal - 12" Sp.Gr. - 1.5 UC & ES - N.D. Sand - 9" UC & ES - N.D. Garnet - 3" UC & ES - N.D.	7.7 mg/l Average of 10 monthly averages following: post-aeration & activated carbon	85%	Alum - 10 mg/l Polymer - 0.1 mg/l Activated Carbon - 15 mg/l added in-line just ahead filters
A-5	Reconstituted tobacco	Activated sludge - 15.1 lb BOD$_5$/1000 cu.ft. F/M - .07 MLSS - 3500 mg/l DO Min - Detention time - 120 hrs @ 1.0 MGD Average flow - 1.0 MGD	N.D.	1.25μ - 21.2 2.5μ - 52.9 5.0μ - 78.2	at 1.0 MGD and 3 filters 46 gpm/sq. ft.	2 Media - coal,sand Coal - 26" ES - 1.2 mm UC - N.D. Sand - 19" ES - 0.5 mm UC - N.D.	N.D.	N.D.	Polymer added at overflow weir of aeration basin Dosage - N.D.
A-8	Paper towels and napkins	Aerated stabilization basin	163 mg/l Average of 6 monthly averages of one grab sample	1.25μ - 49.8 2.5μ - 84.2 5.0μ - 90.6	4 gpm/sq. ft.	2 Medias-coal,sand Coal - 18" ES - 1.5 mm Sand - 12" ES - 0.7 mm	N.D.	N.D.	N.D.
A-6	Pet food manufacturer	Activated sludge - complete mix N.D. F/M - N.D. MLSS - 3500 mg/l DO Min - Detention time - 90 hrs @ 0.3 MGD Mechanical aeration Average flow - 0.3 MGD	N.D.	1.25μ - 30 2.5μ - 55 5.0μ - 85	@ .3 MGD and 3 filters 2 gpm/sq. ft.	2 Media- coal, sand Coal - 36" Sand - 24"	6.5 mg/l average for April 1976	N.D.	Cationic polymer added to flow just ahead of clarifier Dosage - N.D.
Literature - Cellulose mill on Lake Baikal USSR full scale installation	Tire cord cellulose and kraft paper pulp	Activated sludge - MLSS - 2500 mg/l DO Min - Detention time - 8 hrs @ 76 MGD Average flow -	N.D.	N.D.	2.7 gpm/sq ft	1 Media - sand ES - 1.2 - 2.0 mm 9.6 ft drop	5 mg/l following 6 hr settling lagoon & 6 hr aerated lagoon	N.D.	Alum - 80 mg/l Polymer - 1.0 mg/l (anionic) ahead of chemical clarifier
Literature Amoco Oil Yorktown,VA.	Oil refining	Aerated lagoon - F/M - MLSS - DO. Min. - Detention time - Average flow -	57.6 mg/l	N.D.	3.6 gpm/sq ft.	3 Media-coal,sand,garnet Coal - 22" Sand - 11" illmenite - 7"	27.5 mg/l Average of 5 period averages June 1971 to December 1972	52%	Alum - just ahead filters

NOTES: *Based on one grab sample.
ND = No Data

TABLE VII-19

FINAL EFFLUENT QUALITY FOLLOWING THREE LAYER PRESSURE SAND FILTRATION OF THE EFFLUENT FROM AN AERATED STABILIZATION BASIN TREATING PAPERBOARD FROM WASTEPAPER WASTEWATER

	BOD_5 (mg/l)		TSS (mg/l)	
Date	Average for Month	Maximum Day	Average for Month	Maximum Day
September 1978	11	17	12	20
October 1978	9	15	12	16
November 1978	9	14	8	12
December 1978	11	14	7	16
January 1979	14	19	11	18
February 1979	16	19	13	20
March 1979	14	19	12	24
April 1979	10	17	14	20
May 1979	10	17	11	20
June 1979	12	16	11	16
July 1979	14	19	14	20
August 1979	17	40	17	30
September 1979	19	28	21	24
October 1979	16	23	20	40
November 1979	--	--	21	22
December 1979	14	24	22	32
January 1980	17	25	23	34
February 1980	19	35	18	49
March 1980	18	35	20	36
April 1980	17	25	18	46
May 1980	13	33	12	40
June 1980	13	18	17	44
July 1980	12	23	19	44
August 1980	16	30	23	46
September 1980	12	30	12	40
October 1980	12	39	17	50
November 1980	5	10	7	24
December 1980	14	34	16	50
January 1981	11	35	12	48
February 1981	--	--	--	--
March 1981	7	35	11	40

TABLE VII-20

FINAL EFFLUENT QUALITY FOLLOWING DEEP BED SAND FILTRATION OF THE EFFLUENT FROM AN AERATED STABILIZATION BASIN AND SECONDARY CLARIFIER TREATING PAPERBOARD FROM WASTEPAPER WASTEWATER

	BOD_5 (mg/l)		TSS (mg/l)	
Date	Average for Month	Maximum Day	Average for Month	Maximum Day
December 1978	38	42	49	60
January 1979	44	62	54	100
February 1979	41	46	44	65
March 1979	44	52	55	66
April 1979	54	70	51	89
May 1979	32	62	53	88
June 1979	20	36	27	42
July 1979	29	32	37	44
August 1979	30	40	30	37
September 1979	31	60	33	46
October 1979	35	44	40	54
November 1979	29	50	46	60
December 1979	39	56	59	75
January 1980	38	70	45	70
February 1980	27	40	44	65
March 1980	30	50	48	70
April 1980	34	75	52	85
May 1980	24	36	31	44
June 1980	30	59	28	61
July 1980	--	--	--	--
August 1980	32	46	22	33
September 1980	33	51	38	50
October 1980	44	68	48	70
November 1980	52	62	66	78
December 1980	36	53	64	92
January 1981	45	78	56	75
February 1981	41	61	67	95
March 1981	104	310	55	80
April 1981	39	54	57	99

TABLE VII-21

FINAL EFFLUENT QUALITY FOLLOWING RAPID GRAVITY SAND FILTRATION OF THE EFFLUENT FROM AN ACTIVATED SLUDGE PLANT TREATING PAPERBOARD FROM WASTEPAPER WASTEWATER

Date	BOD5 (mg/l) Average for Month	BOD5 (mg/l) Maximum Day	TSS (mg/l) Average for Month	TSS (mg/l) Maximum Day
February 1979	13	34	47	205
March 1979	8	15	29	76
April 1979	12	22	20	58
May 1979	6	8	19	88
June 1979	6	9	12	52
July 1979	18	31	21	84
August 1979	13	34	9	52
September 1979	8	20	12	36
October 1979	36	110	39	75
November 1979	29	86	54	134
December 1979	12	17	29	80
January 1980	5	12	11	24
February 1980	6	11	9	21
March 1980	6	22	8	40
April 1980	7	20	8	33
May 1980	6	20	9	21
June 1980	8	16	14	50
July 1980	2	3	7	18
August 1980	3	10	9	19
September 1980	6	16	8	33
October 1980	4	8	11	26
November 1980	6	9	18	19
December 1980	5	21	10	37
January 1981	7	16	14	38
February 1981	11	49	31	120
March 1981	10	37	19	82

TABLE VII-22

SAND FILTRATION RESULTS[1]

Mill No.	Initial TSS (mg/l)	TSS Removal (%)	
		w/chemicals	w/o chemicals
1	110	64	14
2	5.5		36
3	70	71	68
5	60		23

[1] Peterson, R.R. and Graham, J.L., "Post Biological Solids Characterization and Removal from Pulp Mill Effluents," EPA-600/2-79-037, January 1979.(140)

applied to a well-treated biological effluent, it is capable of reducing BOD_5 to less than 2.0 mg/l.(153)

The primary means of removal is surface adsorption. The key to the carbon adsorption process is the extremely large surface area of the carbon, typically 3.54 to 9.92 square meters per gram (sq m/g) (17,300 to 48,540 sq ft/lb).(154)

Activated carbon will not remove certain low molecular weight organic substances, particularly methanol, a common constituent of pulping effluents.(155) Additionally, carbon columns do a relatively poor job of removing turbidity and associated organic matter.(156) Some highly polar organic molecules such as carbohydrates also will not be removed through the application of activated carbon treatment.(156)(157) However, most of these materials are biodegradable and, therefore, should not be present in appreciable quantities in a well bio-oxidized effluent.

Activated carbon may be employed in several forms including: a) granular, b) powdered, and c) fine. The ultimate adsorption capacities for each may be similar.(158) The optimal carbon form for a given application should be determined by laboratory and/or pilot testing. Each of the three forms of carbon listed above is discussed below.

Granular Activated Carbon. Granular activated carbon has been used for many years at municipalities and industrial facilities to purify potable and process water. In recent years, it has also been used for removal of organics in wastewater.(159)

Granular activated carbon (GAC) treatment usually consists of one or more trains of carbon columns or beds, including one or more columns per train. The flow scheme may be down through a column, up through a packed carbon bed, or up through an expanded carbon bed. The optimum column configuration, flow scheme, and carbon requirements can best be determined through field testing. Design aspects for various systems are readily available in the literature.(154)

It can be economically advantageous in many granular activated carbon applications to regenerate the exhausted carbon. Controlled heating in a multiple-hearth furnace is currently the best procedure for removing adsorbed organics from activated carbon. Typically, the regeneration sequence is as follows:

o Pump exhausted carbon in a water slurry to the regeneration system for dewatering.

o After dewatering, feed the carbon to a furnace at 816° to 927°C (1,500° to 1,700°F) where the adsorbed organics and other impurities are oxidized and volatized.

o Quench the regenerated carbon in water.

- Wash the carbon to remove fines; hydraulically transport the regenerated carbon to storage.

- Scrub the furnace off-gases and return the scrubber water for treatment.

The West Wastewater Treatment Plant at Fitchburg, Massachusetts treats combined papermill and sanitary wastes at a 57,000 cu m/day (15 mgd) chemical coagulation/carbon adsorption facility.(160) Approximately 90 percent of the flow originates from three papermills, with the remaining 10 percent originating from municipal sanitary wastewater. The industrial wastewater undergoes 5 minutes of rapid mixing and 30 minutes of flocculation prior to mixing with the chlorinated sanitary wastewater. The combined waste is then settled after lime and alum addition. The wastewater is then pumped to twelve downflow pressure carbon filters. Initial operation of the system has resulted in a 96 percent suspended solids reduction and a 39 percent BOD_5 reduction in the pretreatment system. The granular activated carbon filters initially yielded total reductions of suspended solids and BOD_5 of 99 and 97 percent, respectively. Final effluent concentrations were reported as 5.0 mg/l BOD_5 and 7.0 mg/l TSS. No data have been reported concerning toxicity or toxic pollutant removal/ reduction from the plant.

Since the plant was started up in late 1975, it has been plagued with a number of mechanical and operational problems. As a result, the system has been unable to achieve the removal capabilities predicted after initial operation. The plant was designed to produce an effluent quality of 8 mg/l of BOD_5 and TSS on a monthly average. The pretreatment facility has consistently yielded a 55 percent BOD_5 reduction and 95 percent TSS reduction. The carbon filters have provided 55 percent BOD_5 reduction and 70 percent TSS reduction of the remaining pollutants after pretreatment. Overall, the system was anticipated to achieve 80 percent BOD_5 reduction and 98 percent TSS reduction once the steady state conditions were met.(161)

Pilot testing by Beak Consultants, Ltd., with laboratory analysis confirmed by B.C. Research, indicates that approximately 80 percent of each of the following resin and fatty acids were removed from raw bleached kraft effluents by application of granular carbon adsorption: pimaric, isopimaric, abietic, dehydroabietic, oleic, linoleic, and linolenic.(162) Initial total resin acid and fatty acid concentrations were 10.6 and 3.9 mg/l as reported by Beak Consultants, Ltd. and 12.6 and 2.2 mg/l as reported by B.C. Research. Total resin acid and total fatty acid concentrations in the treated effluent were 1.49 and 2.4 mg/l as reported by Beak Consultants, Ltd. and 2.25 and 0.4 mg/l as reported by B.C. Research. A contact time of 7.5 minutes with a carbon exhaustion rate of 0.6 to 0.7 kg per 1,000 liters (5.0 to 6.0 lb per 1,000 gallons) was employed in the study. Detoxification of the raw woodroom wastewater was successful. However, the authors report that the carbon system did not detoxify whole mill effluent during a simulated black liquor spill, even with a contact time of 30 minutes.

It is noteworthy that the carbon exhaustion rate for BOD5 removal was 20 times shorter than that for toxicity removal. These results imply that (a) carbon life may be significantly increased if competing organics are removed prior to carbon adsorption and (b) carbon adsorption capacity for resin and fatty acids is greater than that for other biodegradable organics.

Several researchers have considered the reuse of wastewaters following carbon adsorption treatment. Kimura showed that the use of activated carbon following biological treatment and sand filtration was capable of completely detoxifying kraft board mill wastewater. In this application, the final effluent was recycled as process water.(163)

According to Smith and Berger, pulp and papermill wastewater suitable for reuse can be obtained using granular carbon without a biological oxidation step, particularly if the raw wastewater exhibits a BOD5 of 200 to 300 mg/l.(164) Color due to refractory organic compounds contained in pulping effluents can also be reduced by such treatment. Table VII-23 presents the pilot plant results obtained by the authors.

Condensate streams account for only about 2 to 10 percent of total wastewater flow, but contribute significantly higher proportions of toxicity and BOD5 when discharged. Tests by Hansen and Burgess showed that 70 to 75 percent of the BOD5, COD, and TOC in kraft evaporator condensate could be removed using 0.46 kg of carbon per 1,000 liters (3.8 lb of carbon per 1,000 gallons) of wastewater.(157) Treatment with granular activated carbon reduced the effluent toxicity effects on bay mussels by a factor of up to 17. The toxicity removal efficiency was found to be much more dependent on contact time than were BOD5 and COD removals. For example, a contact time of 30 minutes and a carbon dosage of 40.1 g/l (0.334 lb/gal) resulted in an 80 percent COD reduction to 186 mg/l and an 85 percent larval survival in a 10 percent condensate solution. However, an extended contact time of 19 hours under otherwise similar conditions resulted in an increase to only 82 percent COD reduction, or 163 mg/l, while larval survival in 10 percent solution increased to essentially 100 percent.

Weber and Morris found that the adsorption capacity of granular activated carbon increased with a decrease in pH.(165) The effect on the rate of adsorption with changes in temperature was not well defined.

Powdered Activated Carbon. A recent variation of activated carbon technology involves the addition of powdered activated carbon to biological treatment systems. The adsorbant quality of carbon, which has been known for many years, aids in the removal of organic materials in the biological treatment process.(166) This treatment technique also enhances color removal, clarification, system stability, and BOD5 and COD removal.(167)(168) Results of pilot testing indicate that this type of treatment, when used as a part of the activated sludge process, is a viable alternative to granular carbon systems.(169)(170) Pilot tests have also shown that powdered

TABLE VII-23

RESULTS OF PILOT-SCALE GRANULAR ACTIVATED CARBON TREATMENT OF UNBLEACHED KRAFT MILL WASTE[1]

Parameter	Desired Range	Raw Waste	After Lime Treatment	After Carbon Treatment	Removal (%)
pH	6.8-7.3	7.8	11.9	10.5	--
Color (Pt-Co Units)	0-5	1,280	28	0	100
BOD5 (mg/l)	0-2	265	82	12	95.5
COD (mg/l)	0-8	517	320	209	59.6
Suspended Solids (mg/l)	0-5	128	115	74	42.2
Total Solids (mg/l)	50-250	1,210	1,285	1,205	0.4

Note: Columns were loaded at 3.6-4.0 gpm/sq ft activated carbon can be used successfully with rotating biological contactors.(171)

---

[1] Smith, D.R. and Berger, H.F., "Wastewater Renovation," TAPPI, Vol. 51, No. 10, October 1968.(164)

At a large chemical manufacturing complex, a full-scale, 151,000 cu m/day (40 mgd), powdered activated carbon system was started up during the spring of 1977.(172) This system includes carbon regeneration. The waste sludge, which contains powdered carbon, is removed from the activated sludge system and is thickened in a gravity thickener. The sludge is then dewatered in a filter press prior to being fed to the regeneration furnace. The regenerated carbon is washed in an acid solution to remove metals as well as other inorganic materials. Fresh carbon is added as make-up to replace the carbon lost in the overflow from the activated sludge process or from the regeneration system.

The process was originally developed because biological treatment alone could not adequately remove the poorly biodegradable organics in the effluent. Data were taken during operation of a laboratory-scale powdered activated carbon unit using a carbon dosage of 160 mg/l and a hydraulic retention of 6.1 hours. Table VII-24 presents the results of this investigation.(172)

It is noteworthy that the estimated capital costs of using powdered activated carbon rather than a conventional activated sludge system at this chemical plant were within 10 percent of each other. Operating cost of the powdered activated carbon system was estimated to be about 25 percent greater than for conventional activated sludge alone.(172)

The powdered activated carbon system described above is a very comlex treatment system that involves operations that may not be required at other installations. The need for a filter press system or acid cleaning system as well as a carbon regeneration furnace must be determined on a case-by-case basis.

In a follow-up study on the full-scale powdered activated carbon activated sludge plant, the average results of three months of data are reported in Table VII-25. The carbon dosage was 182 mg/l, while the hydraulic retention was 14.6 hours.(173)

Comparison of the laboratory and full-scale results in Tables VII-23 and VII-24 reflect an increase in BOD5 and color removal for the full-scale system over that of the laboratory-scale unit.

Fine Activated Carbon. Timpe and Lang developed a fine activated carbon system for which they filed a patent application.(158) It is a multi-stage, countercurrent, agitated system with a continuous transfer of both carbon and liquid. One of the major aspects of the fine activated carbon system is the use of an intermediate-size carbon in an attempt to combine the advantages of both powdered and granular carbon while minimizing their limitations. Equipment size and carbon inventory are decreased due to the increased adsorption rate of the intermediate-size carbon.

TABLE VII-24

POWDERED ACTIVATED CARBON
OPERATING DATA ON A CHEMICAL PLANT WASTEWATER[1]

Parameter	Raw Effluent	Final Effluent	Percent Removal
Soluble BOD_5 (mg/l)	300	23	92.3
Color (APHA Units)	1,690	310	81.6

[1] Source: Heath, H.W., Jr., E.I. duPont de Nemours and Company, "Combined Powdered Activated Carbon-Biological (PACT) Treatment of 40 MGD Industrial Waste," presented to Symposium on Industrial Waste Pollution Control, American Chemical Society National Meeting, March 1977.(172)

TABLE VII-25

FULL SCALE "PACT" PROCESS RESULTS ON CHEMICAL PLANT WASTEWATER[1]

Parameter	Raw Effluent	Final Effluent	Percent Reduction
Soluble BOD5 (mg/1)	504	15.2	95
Color (APHA Units)	1,416	311	78

---

[1] Robertaccio, F.L., "Combined Powdered Activated Carbon - Biological Treatment: Theory and Results," Proceedings of the Open Forum on Management of Petroleum Refinery Wastewaters, June 1977.(173)

Timpe and Lang report that the fine activated carbon system showed distinct advantages over the granular activated carbon system. They ran extensive pilot plant tests for treating unbleached kraft mill wastewater with granular and fine activated carbon.(158) Four different treatment processes were investigated using a 110 liter per minute (30 gpm) pilot plant: (a) clarification followed by downflow granular activated carbon columns, (b) lime treatment and clarification followed by granular activated carbon columns, (c) biological oxidation and clarification followed by granular activated carbon columns, and (d) lime treatment and clarification followed by fine activated carbon effluent treatment (subject of a patent application.)

All treatment processes were operated in an attempt to obtain a treated effluent with less than 100 APHA color units and less than 100 mg/l TOC that would allow for reuse of the wastewater in the manufacturing process. The lime-carbon treatment achieved the desired effluent criteria and was considered the most economical of the three processes utilizing carbon columns. A relatively small lime dosage of 320 to 600 mg/l CaO without carbonation prior to carbon treatment was reported to be the optimum operating condition for the lime-carbon process. It was determined that the effluent should contain about 80 mg/l Ca for successful optimization of treatment. The required fresh carbon dosage was 0.3 kg of carbon per 1,000 liters treated (2.5 lb per 1,000 gallons treated).

Timpe and Lang reported lower rates of adsorption, resulting in larger projected capital and operating costs, for the biological-carbon and primary carbon processes in treating unbleached kraft mill effluent.(158) The lower rates of adsorption were believed to be caused by coagulation of colloidal color bodies on the carbon surface. They also determined that the use of sand filters prior to the activated carbon was not necessary. The carbon columns operated with a suspended solids concentration of 200 mg/l without problems when backwashed every day or two. Filtration or coagulation of the effluent from the fine activated carbon process was necessary in order to remove the color bodies that formed on the outer surfaces of the activated carbon granules.

The authors found that nonadsorptive mechanisms accounted for a significant amount of color and TOC removal in the clarification-carbon process. They felt that the removals were not due to any biological degradation that might have occurred in the carbon columns. The color colloids were subsequently removed as large settleable solids during the backwashing process.(158) Table VII-26 tabulates the pilot plant results obtained from Timpe and Lang's investigation.

Foam Separation

Foam separation techniques have been evaluated to determine their effectiveness in treating surface active substances (i.e., resin acids) in pulp, paper, and paperboard mill wastewaters. This process involves physical removal of surface active substances through foam

TABLE VII-26

RESULTS OF PILOT-SCALE ACTIVATED CARBON TREATMENT OF UNBLEACHED KRAFT MILL EFFLUENT[1]

Description of Carbon Process	Columns Preceded By Biological Oxidation & Clarification			Columns Preceded By Primary Clarification			Columns Preceded By Primary Clarification			Columns Preceded By Lime Treatment & Clarification			FACET System		
	Inf.	Eff.	Removal	Inf.	Eff.	Removal	Inf.	Eff.	Removal	Inf.	Eff.	Removal	Inf.	Eff.	Removal
BOD (mg/l)										26% Removal					
TOC (mg/l)	148	57	61%	220	83	62%	310	121	61%	177	100	44%	158	101	36%
Turbidity (JTU)											5-15				
Color (Pt-Co Units)	740	212	71%	925	185	80%	1100	202	83%	252	76	70%	157	73(a)	54%
Hydraulic Load (gpm/sq ft)	2.13			1.42			0.71			1.42			--		
Carbon	Granular			Granular			Granular			Granular			Intermediate		
Contact Time (Min)	140									108					
Fresh Carbon Dosage (lb carbon/ 1000 gal.)	8			20.5			28			2.5			3.9		
pH										11.3					

---

[1] Source: Timpe, W.G. and Lang, E.W., "Activated Carbon Treatment of Unbleached Kraft Effluent for Reuse - Pilot Plant Results," TAPPI Environmental Conference, San Francisco, May 1973.(158)

(a) Filtered

generation. In this process, fine air bubbles are introduced into a basin or structure containing the effluent. The air bubbles cause generation of foam in which the surface active compounds are concentrated. Jet air dispersion has been found to be the most efficient technique for foam generation when compared to turbine and helical generation systems.(174)

Several full-scale foam separation facilities have been built for the removal of detergents from municipal wastes.(175)(176) The Los Angeles County Sanitation District system operated a system treating a flow of 45,000 cu m/day (12 mgd) at a seven minute detention. Water reclamation was the primary purpose of the unit, which operated successfully and trouble-free during two years of continuous operation.(177) This system, like other municipal systems, has ceased operation due to regulations that require the use of biodegradable detergents.

A bleached kraft whole mill effluent was analyzed for total resin acid content before and after treatment in a pilot-scale foam separation unit.(177) Two mill effluents were treated in a two hour detention time foam separation pilot unit. The resin acid content in all cases was reduced by between 46 and 66 percent. The range of total resin acid content in the influents and effluents was 2.6 to 5.1 mg/l and 0.1 to 1.0 mg/l, respectively. In all cases, the treated effluent was rendered nontoxic to fish.

Pilot studies were performed using foam separation as a pretreatment prior to the application of activated sludge and aerated stabilization treatment of bleached kraft effluent.(178) These studies indicated that the detoxification efficiency of biological treatment can improve from 50 to 85 percent of the time without foam separation to over 90 percent of the time with foam separation.(178)

Microstraining

At two nonintegrated papermills, full-scale coagulation/microstraining facilities are used for treating rag pulp and fine paper effluents.(179)(180) Coagulant usage includes the addition of 1 mg/l of polymer plus the addition of alum or caustic for pH adjustment. Typically, suspended solids and BOD_5 reductions to 10 mg/l and 50 mg/l, respectively, are achieved. When properly operating, treatment approaching that achievable through the application of biological treatment has been obtained. It has been observed that upsets caused by such practices as paper machine washup with high alkaline cleaners affect the effectiveness of the technology.(179)

Electrochemical Treatment

Electrochemical treatment technology involves the application of an electrical current to the effluent to convert chloride to chlorate, hypochlorite, and chlorine. The chlorine and hypochlorite can oxidize organic compounds and be reduced again to chloride ions. The process then repeats in a catalytic fashion. The oxidation of organic compounds reduces the BOD_5, color, and toxicity of the effluent. A significant advantage of the process is that no sludge is produced.

Oher found that an 80 percent reduction of color in whole mill bleached kraft effluent and a 90 percent reduction of color in caustic extract could be achieved through electrochemical treatment.(181) Similar results were achieved when using a lead dioxide or a graphite anode. The lead dioxide anode required less energy. No toxicity or toxic pollutant data were reported.

In a variation of the process, Barringer Research Ltd. investigated the use of a carbon fiber electrochemical reactor to treat kraft caustic extracts.(182) The high surface to volume ratio of the carbon greatly decreased the reactor volume requirements. At an effluent to water volume ratio of 60 percent (v/v), toxicity was reported to be reduced from 10 percent mortality in 22 hours to zero percent mortality in 96 hours. Color reduction of 90 percent and BOD_5 and COD reductions of 50 percent and 60 percent, respectively, were reported. This process is in full-scale use in the mining industry, but no pilot or mill-scale unit has been applied in the pulp, paper, and paperboard industry.(183) The primary drawback of the process is failure of the carbon cell to perform for extended periods.(183)

Another variation to this process involves the use of hydrogen gas bubbles generated in the process to float solids and separate scum. Selivanov found that an electrochemical unit with graphite anodes and stainless steel cathodes could cause coagulation in kraft white water.(184) Release of hydrogen bubbles in the process caused solids removal by flotation. Total suspended solids were reduced to 2 to 4 mg/l. No toxicity data were reported.

Herer and Woodard found significant color and TOC reductions in bleachery wastes by application of electrolytic cells using an aluminum anode.(185) Color removals from chlorination and caustic extraction effluents were 92 percent and 99 percent, respectively, while TOC removals were 69 percent and 89 percent, respectively. Specific concentrations, however, were not reported.

Ion Flotation

This process involves the addition of a surfactant ion of opposite charge to the ion to be removed. The combining of these ions results in a precipitate, the colligend. The colligend is removed by passage of air bubbles through the waste and collection of the resulting floating solids.

Many of the chromophoric (color producing) organics in pulp, paper, and paperboard mill wastewaters are negatively charged, making this process suitable for the removal of color. Chan, et al. investigated the process on a laboratory scale.(186) A variety of commercial grade cationic surfactants were tested and Aliquat 221 produced by General Mills was found to be very effective. The process removed over 95 percent of the color from bleached kraft effluents. No specific removals of toxicity or toxic pollutants were reported.

Air/Catalytic/Chemical Oxidation

Complete oxidation of organics found in pulp, paper, and paperboard mill wastewaters to carbon dioxide and water is a significant potential advantage of oxidation processes. Partial oxidation coupled with biological treatment may have economic and/or technical advantages over biological treatment alone.

Past studies of oxidative processes dealt principally with COD or TOC as a measure of performance. Barclay, et al. completed a thorough compilation of related studies and found that most were performed with wastewater other than those resulting from the production of pulp, paper, and paperboard.(187) Some tentative conclusions, though, may still be drawn:

- Complete oxidation with air can occur under extreme temperature and pressure, high intensity irradiation, with air at ambient conditions in the presence of excessive amounts of strong oxidants (O_3, H_2O_2 or ClO_2), or with air or oxygen in the presence of catalysts such as certain metal oxides.

- Sulfite wastes can be partially detoxified by simple air oxidation for a period of seven days.

- Ozone oxidation achieved only slight detoxification of sulfite wastes after two hours and partial detoxification after eight hours.(187)

- Major BOD_5 reductions can only be achieved under conditions similar to those required for nearly complete oxidation.

No data specifically relating to toxic pollutant removal were reported.

Steam Stripping

Steam stripping involves the removal of volatiles from concentrated streams. Hough and Sallee report that steam stripping at a kraft mill is capable of removing 60 to 85 percent of the BOD_5 from condensate streams.(188) The ability of the process to remove specific pollutants (including toxic and nonconventional pollutants) depends on the relative boiling points of the pollutants with respect to that of water (i.e., the pollutants must be volatile). Resin acids have boiling points in the range of 250°C (482°F) and, thus, are not readily stripped through application of this process.(189)

Steam stripping was evaluated for its ability to detoxify condensates from sulfite waste liquor evaporators.(190) This stream accounted for 10 percent of the whole mill effluent toxicity and 28 percent of the total BOD_5 load. Toxicity in the condensate stream was attributed to acetic acid, furfural, eugenol, juvabione, and abietic acid. The application of steam stripping had no observable effect on the toxicity of the stream, although the total organic content was reduced.

Steam stripping of kraft mill digester and evaporator condensates was employed on a mill scale for control of total reduced sulfur (TRS) compounds and toxicity.(191) The 96-hour LC-50 of the condensate was altered from 1.4 percent to 2.7 percent. Thus, the stream remained highly toxic, even after steam stripping. The process did remove 97 percent of the TRS compounds. Production process changes such as minimizing condensate volume, installation of spill collection systems, reduction of fresh water use, and conversion to dry debarking along with the application of steam stripping resulted in a nontoxic effluent.

Ultrafiltration

Wastewater treatment by ultrafiltration involves removal of macromolecules from wastewater by means of membranes of specified molecular size. Wastewater is forced through the membranes under pressure. The size of the molecules to be removed dictates the permeability (size opening) of the ultrafiltration membrane.

Data are available from Easty for nonconventional pollutant removal from two bleached kraft caustic extraction effluents utilizing two types of ultrafiltration systems.(90) Good removals of epoxystearic acid, dichlorostearic acid, trichloroguaiacol, and tetrachloroguaiacol were obtained in each case. Chlorinated resin acids were effectively removed by one system but not the other.

The first system employed only one spiral wound membrane, with a surface area of 3.7 sq m (40 sq ft). Filtration of suspended solids larger than 10 micrometers (0.004 in) was accomplished prior to ultrafiltration. The system was operated at 28.4 liters per minute (7.5 gpm) and a pH of 11 to 11.5. The system achieved 50 to 80 percent reduction of chlorinated phenolics but only 0 to 15 percent removal of chlorinated resin acids. The lower percent removals of chlorinated resin acids reflect a low initial concentration of these pollutants in the waste.

The second system treated an effluent volume of 12.5 liters per minute (3.3 gpm) using a tubular cellulose acetate membrane with a surface area of 1.1 sq m (12.1 sq ft). The system operated at a pH of 9.5 to 10.5 and inlet and outlet pressures of 15.0 ATM (220 psi) and 6.8 ATM (100 psi), respectively. Filtration of all particles larger than 10 micrometers (0.004 in) was accomplished prior to ultrafiltration. This system removed approximately 80 to 85 percent of all chlorinated resin acids, chlorinated phenolics, and other acids.

Lewell and Williams studied color, lignosulfonate, COD, and solids removals from sulfite liquor after the application of ultrafiltration.(192) Removals on the order of 30 to 50 percent were observed for color, lignosulfonate, COD, and TSS. No toxicity or toxic pollutant data were reported. Costs (1971) were estimated at $0.40/kl ($1.50/kgal) for a 3785 cu m (1.0 mgd) permeate flow. The authors concluded that ultrafiltration could not compete economically with lime as a means of removing lignosulfonate, color, COD, and solids.(192)

Reverse Osmosis/Freeze Concentration

Reverse osmosis employs pressure to force a solvent through the membrane against the natural osmotic force. This is the same type of process as ultrafiltration except that the membranes used for reverse osmosis reject lower molecular weight solutes. This means that lower flux rates occur; there is also a need for a higher operating pressure difference across the membrane than those necessary for ultrafiltration.

Reverse osmosis is employed at a Midwest NSSC mill where 270 kkg/day (300 tpd) of corrugating medium are produced. The system allows operation of a closed white water system. Easty reported that the system achieved BOD_5 reductions of approximately 90 percent and removed essentially all resin and fatty acids.(90) The 320 liter per minute (85 gpm) reverse osmosis unit employs 288 modules, each with 1.55 sq m (16.7 sq ft) of area provided by 18 cellulose acetate tubes. The system operates at 41 ATM (600 psi) and 38°C (100 °F). During Easty's testing, the white water feed contained 300 mg/l TSS and 40,000 to 60,000 mg/l total dissolved solids. Initial resin and fatty acid levels were: abietic, 1.5 mg/l; dehydroabietic, 2.62 mg/l; isopimaric, 2.75 mg/l; pimaric, 0.82 mg/l; oleic, 4.86 mg/l; linoleic, 7.23 mg/l; and linolenic, 0.27 mg/l.(90) The maximum removal capacity is not known since final concentrations were below detection limits.

Reverse osmosis can be followed by freeze concentration whereby the effluent is frozen to selectively remove pollutants. Freeze concentration takes advantage of the fact that when most aqueous solutions freeze, the ice crystal is almost 100 percent water. This process was evaluated by Wiley, *et al*. on three bleachery effluents.(193) Reverse osmosis alone resulted in a concentrate stream of roughly 10 percent of the volume of the raw feed. Freeze concentration reduced the concentrate stream volume by a factor of five while essentially all the impurities were retained in the concentrate. Thus the two processes employed in tandem resulted in a concentrate stream consisting of roughly two percent of the original feed volume that contained essentially all of the dissolved solids.(193) It was reported that the purified effluent was of sufficient quality that it could be returned to the process for reuse.(193) Wiley did not investigate final disposal of the concentrate.

Amine Treatment

This treatment is based upon the ability of high molecular weight amines to form organophilic precipitates. These precipitates are separated and redissolved in a small amount of strong alkaline solution (white water). By so doing, the amine is regenerated for use, with no sludge produced.(194)

The Pulp and Paper Research Institute of Canada (PPRIC) conducted a study to determine the optimum process conditions for employing high molecular weight amines for color, BOD5, and toxicity reductions of bleached kraft mill effluents.(195) While no specific data on toxic or nonconventional pollutants were reported, whole mill bleached kraft effluent remained toxic after application of the treatment in two reported tests. Likewise, acid bleach effluent could not be detoxified. However, alkaline bleaching wastewater was detoxified in three out of four samples at 65 percent dilution. Final effluent concentrations for BOD5, COD, and color after treatment of bleached kraft whole mill wastewater were 80 to 350 mg/l, 380 to 760 mg/l, and 80 to 450 APHA units, respectively. Reported removals were 10 to 74 percent, 36 to 78 percent, and 94 to 98 percent, respectively, using Kemamine T-1902D in a solvent of Soltrol 170.

Polymeric Resin Treatment

Polymeric resin wastewater treatment processes make use of adsorption and ion exchange mechanisms to remove pollutants from the wastewater. Resin columns are commonly employed; they are reactivated after completion of the treatment cycle by means of acid or alkaline solutions. It has been reported that weakly basic ion exchange resins, based on a phenol/formaldehyde matrix, are superior in treating pulp and paper bleach plant effluents.(196) Prior to resin treatment, it is advantageous to screen and filter the waste streams and adjust the pH to 2 or 3.

The resin adsorption approach is being pursued by three companies: Billerud Uddeholm, Rohm and Haas, and Dow Chemical Company. The Rohm and Haas and the Dow Chemical processes are at the pilot plant stage. The Billerud Uddeholm color removal process has been operated as a full-scale batch process in Skoghall, Sweden, since 1973.

Based on the experience gained through operation of the full-scale system in treating the caustic first extraction stage effluent (E_1), treatment was expanded to include chlorination stage washer effluent (C_1). The first full-scale continuous installation began in December of 1980 at Skoghall, Sweden. In this system, a full countercurrent wash is used, and the effluent from the E_1 stage is reused on the C_1 stage washer after color and toxicity removal through the application of resin adsorption.(75)(197)

The pollutants may be removed from the resin by elution with caustic or oxidized white liquor. The eluate at 10 percent concentration is mixed with the weak black liquor to be evaporated and burned in the recovery boiler. The resin is reactivated with the chlorination effluent. The chlorination stage effluent reactivates the resin and is simultaneously decolorized and detoxified. The total mill BOD5 load is reduced by 30 percent and the color load by 90 percent. The flow diagram of this process is shown in Figure VII-33.

The operating costs for the Billerud Uddeholm system are reported as \$3.74 per kkg of production (\$3.40 per ton of production) (1980). The investment cost of an installation for treatment of the effluent from a 310 kkg/day (340 tpd) kraft pulp mill bleach plant is \$4.0 million (1980) including close-up of the bleach plant. The costs will vary depending on wood species, kappa number, and local conditions.(197) These costs are based upon a resin life of one and one-half years.

The Rohm and Haas process involves the use of Amberlite XAD-8 resin to decolorize bleaching effluent after filtration. The resin can be reactivated without the generation of waste sludge. This reactivation may be accomplished by using mill white liquor. In one study, the adsorption capacity of Amberlite XAD-2 resin was compared to Filtrasorb 300 activated carbon. (198) The resin was more effective in removing most aromatic compounds, phthalate esters, and pesticides; carbon was more effective at removing alkenes. Neither adsorbant was effective in removing acidic compounds. The tests involved use of laboratory solutions of 100 organic compounds at an initial concentration of 100 ug/l.

Another study has shown synthetic resin to be capable of removing a higher percentage of COD from biological effluent than carbon. (199) Also, resin treated wastewater quality was improved when further treated with carbon, although the reverse was not true. The economics of this system could prove favorable since resin may be regenerated in situ. Thus, total regeneration costs may be more economical than for either system alone since carbon life could be significantly extended.

Elimination of toxic constituents from bleached kraft effluents has been achieved with Amberlite XAD-2 resin.(200)(201) Wilson and Chappel reported that treatment with Amberlite XAD-2 resin resulted in a nontoxic semi-chemical mill effluent.(202)

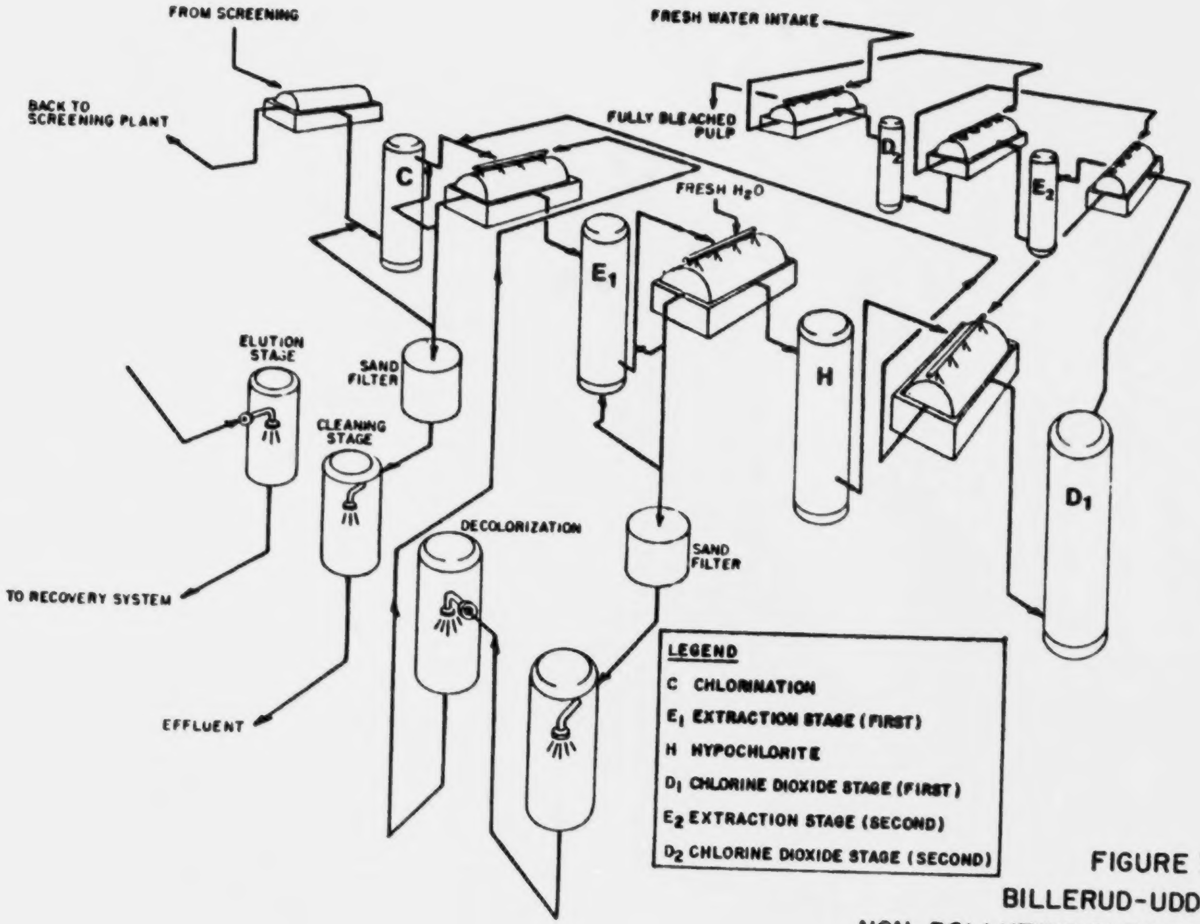

FROM SCREENING
BACK TO SCREENING PLANT
FRESH WATER INTAKE
FULLY BLEACHED PULP
C
D_2
E_2
FRESH H_2O
E_1
H
D_1
ELUTION STAGE
SAND FILTER
CLEANING STAGE
DECOLORIZATION
SAND FILTER
TO RECOVERY SYSTEM
EFFLUENT
LEGEND
C CHLORINATION
E_1 EXTRACTION STAGE (FIRST)
H HYPOCHLORITE
D_1 CHLORINE DIOXIDE STAGE (FIRST)
E_2 EXTRACTION STAGE (SECOND)
D_2 CHLORINE DIOXIDE STAGE (SECOND)

FIGURE VII - 33
BILLERUD-UDDEHOLM
NON-POLLUTING BLEACH PLANT

SECTION VIII
DEVELOPMENT OF CONTROL AND TREATMENT OPTIONS

INTRODUCTION

In Section VII, many control and treatment technologies are discussed and information is presented on their capabilities for removal of conventional, toxic, and nonconventional pollutants from pulp, paper, and paperboard industry wastewaters. From these technologies, EPA identified alternative control and treatment options for detailed analysis that represent a range of pollutant removal capability and cost. This section presents the options that were considered in determining BPT and BAT effluent limitations and NSPS, PSES, and PSNS for the pulp, paper, and paperboard industry.

For BPT, treatment options have been developed for control of conventional pollutants for new subdivisions of two existing subcategories (paperboard from wastepaper and nonintegrated-fine papers) and for four new subcategories (wastepaper-molded products, nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard). For BAT, control and treatment options have been developed for control of toxic and nonconventional pollutants being discharged directly to navigable waters. NSPS treatment options for the control of toxic, conventional, and nonconventional pollutants have been developed for new point source direct discharging mills. Options for control and treatment of toxic pollutants discharged to POTWs have been developed for existing and for new indirect discharging mills (PSES and PSNS).

BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE (BPT)

General

Four new subcategories of the pulp, paper, and paperboard industry have been identified: wastepaper-molded products, nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard. As discussed in Section IV, two existing subcategories have been divided into subdivisions: the paperboard from wastepaper subcategory is separated into the corrugating medium furnish subdivision and the noncorrugating medium furnish subdivision; the nonintegrated-fine papers subcategory is separated into the wood fiber furnish subdivision and the cotton fiber furnish subdivision.

As stated previously, the Act establishes the requirements for development of BPT limitations, which are basically the average of the best existing performance. The best practicable control technology currently available for the wastepaper-molded products subcategory, and for mills in the corrugating medium furnish subdivision of the paperboard from wastepaper subcategory has been identified as biological treatment, which is also the technology on which BPT limitations are based for all other subcategories of the secondary fibers segment of the pulp, paper, and paperboard industry. The best practicable control technology currently available for mills in the cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory has been identified as biological treatment which is also the technology on which BPT limitations are based for all other mills in the nonintegrated-fine papers subcategory.

In Table VIII-1, subcategory average BOD5 and TSS raw waste characteristics for the three new nonintegrated subcategories are compared to the BOD5 and TSS raw waste characteristics that formed the basis of BPT effluent limitations for the nonintegrated-fine papers and the nonintegrated-tissue papers subcategories. This comparison indicates that raw waste loads for these new subcategories are comparable to those of the nonintegrated-tissue papers subcategory. The technology basis of BPT effluent limitations for the nonintegrated-tissue papers subcategory is primary treatment. Primary treatment, therefore, has been selected as the basis for development of BPT effluent limitations for the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories.

The development of raw waste loads and final effluent characteristics for each subcategory is discussed below.

Development of Raw Waste Loads

Paperboard from Wastepaper. Available raw waste load data for mills in the subcategory are presented in Table V-16. As discussed in sections IV and V, the raw waste load BOD5 at mills where corrugating medium furnish is processed has increased since BPT was promulgated. At that time, the average raw waste load BOD5 for mills where corrugating medium furnish is processed was 11.3 kl/kkg (22.5 lb/t). Recent data submitted by representatives of mills 110025 and 110080 indicate that the current raw waste load BOD5 for mills where recycled corrugating medium is processed is 23.0 kg/kkg (46.0 lb/t). Therefore, raw waste loads for mills where corrugating medium furnish is processed have been revised to account for the higher raw waste BOD5 and are: flow - 30.0 kl/kkg (7.2 kgal/t); BOD5 - 23.0 kg/kkg (46.0 lb/t), and TSS - 11.0 kg/kkg (21.9 lb/t).

EPA evaluated available data for the mills where all other kinds of wastepaper are processed; the Agency found that the original BOD5 raw waste load is still representative. Therefore, BPT raw waste loads for noncorrugating medium furnish mills are as originally developed for the subcategory: flow - 30.0 kl/kkg (7.2 kgal/t); BOD5 - 11.3 kg/kkg (22.5 lb/t); and TSS - 11.0 kg/kkg (21.9 lb/t).

Wastepaper-Molded Products. Available raw waste load data for mills in this subcategory are presented in Table V-18. Raw waste loads on which BPT limitations are based are equal to the average of raw waste loads at mills where extensive recycling of effluent is not practiced. This yields flow, BOD5, and TSS raw waste loads of 88.1 kl/kkg (21.1 kgal/t), 7.9 kg/kkg (15.8 lb/t), and 14.8 kg/kkg (29.6 lb/t), respectively.

TABLE VIII-1

AVERAGE RAW WASTE CHARACTERISTICS FOR THE NONINTEGRATED SEGMENT OF THE PULP, PAPER, AND PAPERBOARD INDUSTRY

Subcategory	BPT Technology Basis	Subcategory/Subdivision Raw Waste Characteristics Average BOD5	Average TSS
Nonintegrated-Fine Papers	Biological Treatment		
o Wood Fiber Furnish		209 mg/l	678 mg/l
o Cotton Fiber Furnish		144 mg/l	342 mg/l
Nonintegrated-Tissue Papers	Primary Clarification	120 mg/l	323 mg/l
Nonintegrated-Lightweight Papers	None*	107 mg/l**	312 mg/l**
Nonintegrated-Filter and Nonwoven Papers	None*	73 mg/l	165 mg/l
Nonintegrated-Paperboard	None*	122 mg/l**	685 mg/l**

*Mills in these subcategories were permitted on a case-by-case basis using "best engineering judgement." BPT for these subcategories has been identified as primary treatment, the same technology basis as for the Nonintegrated-Tissue Papers subcategory because of the similarity of raw waste BOD5 characteristics.

**Does not include production of electrical grades of papers.

Nonintegrated-Fine Papers. Available raw waste load data for this subcategory are presented in Table V-22. Data for the subcategory were reevaluated based on comments from industry. As discussed previously, EPA determined that raw waste load flow, BOD5, and TSS were comparable for mills where more than 90.7 kkg (100 tons) of product per day are manufactured and those where less than 90.7 kkg (100 tons) per day are produced, excluding mills where cotton fiber comprises a significant portion of the final product. EPA determined that the cotton fiber mills have higher raw waste flow and BOD5 than other mills in the subcategory. Based on this review, the subcategory has been separated into two subdivisions: wood fiber furnish and cotton fiber furnish. The raw waste loads on which BPT limitations are based for nonintegrated mills where a significant portion of the final product (greater than 4 percent) is comprised of cotton fibers are equal to the average of raw waste loads at these cotton fiber furnish mills, or: flow - 176.5 kl/kkg (42.3 kgal/t); BOD5 - 22.9 kg/kkg (45.8 lb/t); and TSS - 55.2 kg/kkg (110.4 lb/t).

Nonintegrated-Lightweight Papers. Available raw waste load data for this subcategory are presented in Table V-24. BPT raw waste loads for this subcategory are based on the average of raw waste loads at mills in this subcategory. Two product sectors have been considered: (a) lightweight papers and (b) lightweight electrical papers. At mills where lightweight electrical papers are produced, substantially larger quantities of water are discharged than at mills where non-electrical grades are produced. At the only mill for which BOD5 data are available where lightweight electrical grades are produced, the BOD5 raw waste load is lower than the average for non-electrical grades. Average raw waste loads associated with the production of lightweight papers are: flow-203.2 kl/kkg (48.7 kgal/t); BOD5-21.7 kg/kkg (43.3 lb/t); and TSS-63.4 kg/kkg (126.8 lb/t). EPA assumed that BOD5 and TSS raw waste loads associated with the production of electrical grades are the same as for non-electrical grades. This results in raw waste loads for the lightweight electrical papers product sector of: flow-320.9 kl/kkg (76.9 kgal/t); BOD5 - 21.7 kg/kkg (43.3 lb/t); and TSS - 63.4 kg/kkg (126.8 lb/t).

Nonintegrated-Filter and Nonwoven Papers. Available raw waste load data for mills in this subcategory are presented in Table V-25. Initially, it was assumed that the subcategory average raw waste loads would form the basis for proposed BPT effluent limitations. In reviewing raw waste load flow data with respect to frequency of waste significant grade changes, it was determined that none of the four mills where more than one waste significant grade change occurred per day exhibited raw waste load flows that were equal to or lower than the subcategory average raw waste loads. Therefore, the proposed BPT flow basis was revised to reflect the highest average for the various grade change delineations. The BPT raw waste load flow is based on those mills with less than one waste significant grade change per day. The raw waste loads for flow, BOD5, and TSS are 250.0 kl/kkg (59.9 kgal/t), 12.2 kg/kkg (24.3 lb/t), and 27.4 kg/kkg (54.7 lb/t), respectively.

Nonintegrated-Paperboard. Available raw waste load data for this subcategory are presented in Table V-26. The subcategory average raw waste loads, exclusive of electrical and matrix board production, form the basis for proposed BPT. The raw waste loads for flow, BOD5, and TSS are 53.8 kl/kkg (12.9 kgal/t), 10.4 kg/kkg (20.8 lb/t), and 36.9 kg/kkg (73.7 lb/t).

Development of Final Effluent Characteristics

In the Phase II Development Document, EPA developed the following relationship between the anticipated final effluent BOD5 concentration and the BOD5 concentration entering a biological treatment system based on treatment plant performance at those mills used to establish BPT effluent limitations (see Phase II Development Document, page 402) (48):

$$\text{Log BOD5 effluent (mg/l)} = 0.601 \text{ Log BOD5 influent (mg/l)} - 0.020$$

EPA used this relationship in establishing allowances to be added to BPT effluent limitations if wet barking, log or chip washing, or log flumes or ponds were employed at individual mills (see Phase II Development Document, page 558).(48)

In Figure VIII-1, EPA has plotted the BOD5 raw waste concentration that formed the basis of BPT versus the final effluent TSS concentration that formed the basis of BPT for the dissolving kraft, market bleached kraft, fine bleached kraft, BCT (board, coarse, and tissue) bleached kraft, dissolving sulfite pulp, papergrade sulfite, soda, groundwood, and deink subcategories. It is apparent that final effluent TSS concentrations are related to raw waste BOD5 concentrations when biological treatment is employed. This relationship is defined by the following equation:

$$\text{Final effluent TSS (mg/l)} = (8.95)\,(\text{Raw Waste BOD5 (mg/l)})^{0.31}$$

As discussed previously, BPT for the corrugating medium furnish subdivision of the paperboard from wastepaper subcategory and the wastepaper-molded products subcategory has been identified as biological treatment. Therefore, the above relationships, which predict the BOD5 and TSS final effluent concentrations that result from the application of biological treatment consistent with the biological treatment systems that form the basis of BPT effluent limitations for the major portions of the pulp, paper, and paperboard industry, are applicable. The long-term average BPT BOD5 and TSS final effluent concentrations for mills in the corrugating medium furnish subdivision of the paperboard from wastepaper subcategory and the wastepaper-molded products subcategory are based on the predicted performance of biological treatment applied to the subcategory/subdivision average BOD5 raw waste concentrations. Long-term average BPT final effluent loads were calculated as the product of the long-term average BOD5 and TSS final effluent concentrations and the flows that form the basis of BPT for these subcategory/subdivisions.

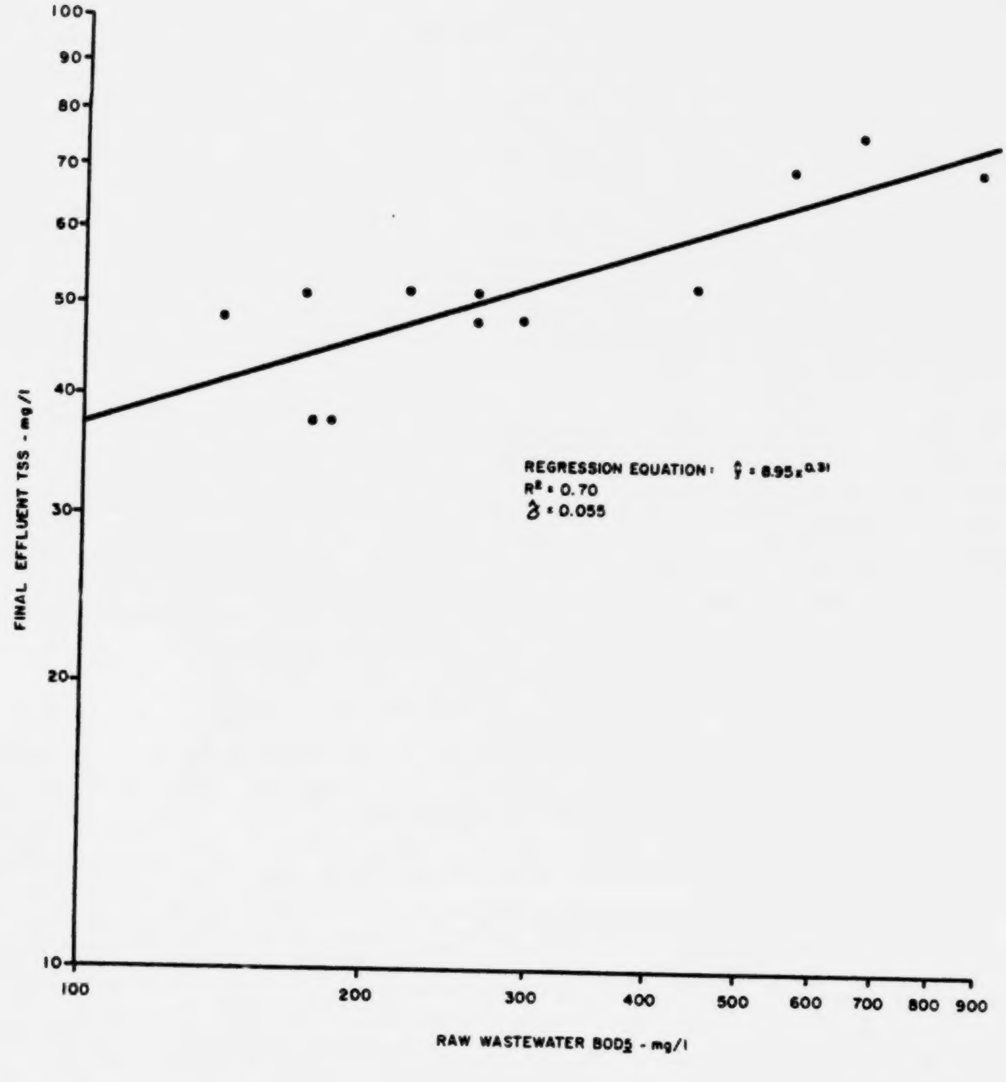


FIGURE VIII - 1
FINAL EFFLUENT TSS VS
RAW WASTEWATER BOD5

As discussed previously, BPT for the cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory has been identified as biological treatment. The BPT BOD5 effluent limitation promulgated for the nonintegrated-fine papers subcategory in 1977 is much less stringent than BOD5 effluent limitations for other subcategories with comparable BOD5 raw waste characteristics. Therefore, EPA did not base the long-term average BPT BOD5 final effluent concentration for this new subdivision on the relationship between BOD5 final effluent concentration and BOD5 raw waste concentration discussed previously. Rather, the long-term average BPT BOD5 final effluent concentration for the cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory is based on the transfer of the performance of biological treatment characteristic of all other mills in the nonintegrated-fine papers subcategory. EPA applied the same percent reduction in BOD5 (77.7 percent) that forms the basis of BPT limitations promulgated in 1977 for the nonintegrated-fine papers subcategory to the BOD5 raw waste load for mills in the newly-established cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory. The long-term average BPT TSS final effluent characteristics were developed from the relationship illustrated in Figure VIII-1. Long-term average loads were calculated as the product of the long-term average BOD5 and TSS final effluent concentrations and the flow that forms the basis of BPT for this new subdivision.

As discussed previously, BPT for the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories has been identified as primary treatment. As shown in Table VIII-1, raw waste characteristics for these new subcategories are comparable to raw waste characteristics for the nonintegrated-tissue papers subcategory. EPA believes that it is reasonable to predict that the application of primary treatment in these three new subcategories will yield final effluent concentrations identical to those that form the basis of BPT effluent limitations for the nonintegrated-tissue papers subcategory. Therefore, the long-term average BPT final effluent concentrations for the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories are based on a transfer of performance from the nonintegrated-tissue papers subcategory. Long-term average loads were calculated as the product of (a) the long-term average BPT BOD5 and TSS final effluent concentrations that were developed for the nonintegrated-tissue papers subcategory and (b) the raw waste load flows that form the basis of BPT for the three new subcategories.

BPT long-term average final effluent characteristics for the four new subcategories and two new subdivisions of the pulp, paper, and paperboard industry are presented in Table VIII-2.

TABLE VIII-2
BPT LONG-TERM AVERAGE
FINAL EFFLUENT CHARACTERISTICS

Subcategory	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Paperboard From Wastepaper						
o Corrugating Medium Furnish	30.0	(7.2)	1.6	(3.1)	2.1	(4.2)
Wastepaper-Molded Products	88.1	(21.1)	1.3	(2.6)	3.2	(6.4)
Nonintegrated-Fine Papers						
o Cotton Fiber Furnish	176.5	(42.3)	5.1	(10.2)	7.2	(14.3)
Nonintegrated-Lightweight Papers						
o Lightweight	203.2	(48.7)	7.4	(14.7)	6.0	(12.0)
o Electrical	320.9	(76.9)	11.7	(23.3)	9.5	(18.9)
Nonintegrated-Filter and Nonwoven Papers	250.0	(59.9)	9.1	(18.1)	7.4	(14.7)
Nonintegrated-Paperboard	53.8	(12.9)	2.0	(3.9)	1.6	(3.2)

BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY (BCT)

General

Section 301(b)(2)(E) of the Clean Water Act of 1977 requires that BCT effluent limitations are to be established for control of conventional pollutants from existing industrial point sources. Conventional pollutants are those defined in section 304(a)(4) and include BOD, suspended solids, fecal coliform, and pH and any additional pollutants defined by the Administrator as conventional (oil and grease; 44 FR 44501, July 30, 1979).

BCT is not an additional limitation, but replaces BAT for the control of conventional pollutants. In addition to other factors specified in section 304(b)(4)(B), the Act requires that BCT limitations be assessed in light of a two part "cost-reasonableness" test (American Paper Institute v. EPA, 660 F.2d 954 (4th Cir. 1981)). The first test compares the cost for private industry to reduce its conventional pollutants with the costs to publicly owned treatment works for similar levels of reduction in their discharge of these pollutants. The second test examines the cost-effectiveness of additional industrial treatment beyond BPT. EPA must find that limitations are "reasonable" under both tests before establishing them as BCT. In no case may BCT be less stringent than BPT.

EPA published its methodology for carrying out the BCT analysis on August 29, 1979 (44 FR 50732). In the case mentioned above, the Court of Appeals ordered EPA to correct data errors underlying EPA's calculation of the first test, and to apply the second cost test. (EPA had argued that a second cost test was not required.)

In a previous document, EPA identified four technology options that are capable of removing significant amounts of conventional pollutants, including:

(A) Option 1 - Base effluent limitations on the technology on which BPT is based for each subcategory plus additional in-plant production process controls. No additional end-of-pipe technology beyond BPT is contemplated in this option.

(B) Option 2 - Base effluent limitations on the addition of chemically assisted clarification of BPT final effluents for all integrated and secondary fiber subcategories and for the nonintegrated-fine papers subcategory (for these subcategories BPT is based on biological treatment). For the remaining nonintegrated subcategories, for which primary treatment is the basis of existing BPT, effluent limitations are based on the addition of biological treatment.

(C) Option 3 - Base effluent limitations on BCT Option 1 plus the addition of chemically assisted clarification for all integrated and secondary fiber subcategories and for the nonintegrated-fine papers subcategory (for these subcategories

BPT is based on biological treatment). For the remaining nonintegrated subcategories, for which primary treatment is the basis of existing BPT, effluent limitations are based on the application of BCT Option 1 plus the addition of biological treatment.

(D) Option 4 - Base effluent limitations on the levels attained at best performing mills in the respective subcategories. The technologies for achieving Option 4 effluent limitations vary depending on the types of treatment systems that are employed at mills in each subcategory.

Because EPA has not yet promulgated a revised BCT methodology in response to the American Paper Institute v. EPA decision mentioned earlier, this document does not include specific information on these four technology options. For further discussion of these four technology options, see (a) 46 FR 1430; January 6, 1981 and (b) Proposed Development Document for Effluent Limitations Guidelines and Standards for the Pulp, Paper, and Paperboard and the Builders' Paper and Board Mills Point Source Categories, U.S. EPA, December 1980.(203) EPA is deferring a final decision on the appropriate BCT limitations until EPA promulgates the revised BCT methodology.

NEW SOURCE PERFORMANCE STANDARDS--CONVENTIONAL POLLUTANTS

General

Section 306 of the Clean Water Act of 1977 requires that new source performance standards (NSPS) be established for industrial dischargers based upon the best demonstrated technology. NSPS include the control of conventional, toxic, and nonconventional pollutants. In the pulp, paper, and paperboard industry, the Agency has determined that NSPS should control the same pollutants controlled under BPT and BAT. This section includes a discussion of those technology options considered as the basis of control of conventional pollutants at new sources.

Two options have been developed for the control of conventional pollutants under NSPS:

Option 1 - Control of conventional pollutants based on the effluent limitations attained at best performing mills in the respective subcategories. The technology basis of NSPS Option 1 varies depending on the type of treatment that formed the basis of BPT effluent limitations for each subcategory.

Option 2 - Control of conventional pollutants based on (a) the application of production process controls to reduce wastewater discharge and raw waste loads and (b) end-of-pipe treatment in the form of biological treatment for all subcategories except nonintegrated-tissue papers, nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard, where end-of-pipe treatment is in the form of primary clarification.

Option 1

Option 1 standards are based on the levels attained at best performing mills in the respective subcategories. This approach is described in detail below and, in the majority of cases, involves an assessment of actual effluent data. After determination of NSPS Option 1 effluent standards, the Agency identified appropriate technologies that could achieve these limitations. As discussed below, except for the paperboard from wastepaper, tissue from wastepaper, wastepaper-molded products, and builders' paper and roofing felt subcategories, EPA has defined NSPS Option 1 to include the application of end-of-pipe treatment of those raw waste loads that formed the basis of BPT effluent limitations. Therefore, except for the four subcategories mentioned above, the NSPS Option 1 raw waste loads which are presented in Table VIII-3 are identical to the raw waste loads that formed the basis of BPT effluent limitations.

The technologies for achieving Option 1 effluent limitations vary depending on the technology basis of BPT effluent limitations for each subcategory. As discussed in detail later in this section, for all subcategories in the integrated segment and for the nonintegrated-fine papers and deink subcategories, where BPT was identified as biological treatment, the activated sludge process is the technology basis of NSPS Option 1. Treatment system design criteria were established that reflect attainment of NSPS Option 1 effluent standards through implementation of end-of-pipe treatment of the raw waste loads that form the basis of BPT effluent limitations for these subcategories. Treatment schemes were identified and used in the development of cost estimates presented in Appendix A. Specific design criteria are also presented in Appendix A. The activated sludge system includes spill prevention and control systems, equalization, aeration basins and provision for operation in the contact stabilization mode, and clarification and sludge handling equipment.

At mills in the nonintegrated subcategories where BPT effluent limitations are based on primary treatment, the technology basis of NSPS Option 1 is primary clarification. Design criteria were established that reflect attainment of NSPS Option 1 effluent characteristics through implementation of end-of-pipe treatment of the raw waste loads that form the basis of BPT effluent limitations for these subcategories. The primary clarification system includes chemical coagulant addition and sludge handling capability.

At mills in the remaining subcategories (paperboard from wastepaper, tissue from wastepaper, wastepaper-molded products, and builders' paper and roofing felt), extensive use is made of production process controls to reduce wastewater discharge. NSPS Option 1 for these subcategories is identical to NSPS Option 2 and includes the application of production process controls and biological treatment, in the form of conventional activated sludge. The end-of-pipe biological treatment systems are identical in size to those which form the basis of BPT effluent limitations for these subcategories (i.e., biological treatment system design is based on attainment of BPT

TABLE VIII-3

SUMMARY OF NSPS OPTION 1
RAW WASTE LOADS

	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Integrated Segment						
Dissolving Kraft	230.0	(55.1)	66.5	(133.0)	113.0	(226.0)
Market Bleached Kraft	173.0	(41.6)	38.0	(75.9)	45.0	(90.0)
BCT Bleached Kraft	148.0	(35.4)	38.4	(76.7)	66.5	(133.0)
Alkaline-Fine[1]	129.0	(30.9)	33.6	(67.2)	75.0	(150.0)
Unbleached Kraft						
o Linerboard	52.5	(12.6)	16.9	(33.8)	21.9	(43.8)
o Bag	52.5	(12.6)	24.3	(48.6)	21.9	(43.8)
Semi-Chemical	42.9	(10.3)	25.2	(50.4)	12.3	(24.6)
Unbleached Kraft and Semi-Chemical	58.4	(14.0)	19.4	(38.8)	20.5	(41.0)
Dissolving Sulfite Pulp						
o Nitration	275.0	(66.0)	137.0	(274.0)	92.5	(185.0)
o Viscose	275.0	(66.0)	156.0	(312.0)	92.5	(185.0)
o Cellophane	275.0	(66.0)	181.5	(363.0)	92.5	(185.0)
o Acetate	303.4	(72.7)	266.0	(531.9)	92.5	(185.0)
Papergrade Sulfite[2]	141.9*	(34.0)*	92.5*	(184.9)*	90.0	(180.0)
Groundwood-Thermo-Mechanical	88.0	(21.1)	21.2	(42.4)	39.9	79.8
Groundwood-CMN Papers	99.0	(23.8)	17.4	(34.8)	48.5	97.0
Groundwood-Fine Papers	91.0	(21.9)	16.7	(33.3)	52.5	105.0
Secondary Fibers Segment						
Deink						
o Fine Papers	102.0	(24.4)	90.0	(180.0)	202.5	(405.0)
o Tissue Papers	102.0	(24.4)	90.0	(180.0)	202.5	(405.0)
o Newsprint	67.6	(16.2)	15.9	(31.7)	202.5	(405.0)
Tissue From Wastepaper	68.0	(16.3)	9.7	(19.3)	110.5	(221.0)
Paperboard From Wastepaper						
o Corrugating Medium Furnish	13.4	(3.2)	23.0	(46.0)	11.0	(21.9)
o Noncorrugating Medium Furnish	13.4	(3.2)	11.3	(22.5)	11.0	(21.9)
Wastepaper-Molded Products	23.8	(5.7)	5.5	(10.9)	14.8	(29.6)
Builders' Paper and Roofing Felt	11.3	(2.7)	6.5	(13.0)	35.0	(70.0)
Nonintegrated Segment						
Nonintegrated-Fine Papers						
o Wood Fiber Furnish	63.0	(15.2)	10.8	(21.5)	30.8	(61.6)
o Cotton Fiber Furnish	176.5	(42.3)	22.9	(45.8)	55.2	(110.4)
Nonintegrated-Tissue Papers	96.0	(22.9)	11.5	(22.9)	34.7	(69.4)
Nonintegrated-Lightweight Papers						
o Lightweight	203.2	(48.7)	21.7	(43.3)	63.4	(126.8)
o Electrical	320.9	(76.9)	21.7	(43.3)	63.4	(126.8)
Nonintegrated-Filter and Nonwoven Papers	250.0	(59.9)	12.2	(24.3)	27.4	(54.8)
Nonintegrated-Paperboard	53.8	(12.9)	10.4	(20.8)	36.9	(73.7)

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

*NSPS Option 1 raw waste flow and BOD5 vary with the percent sulfite pulp in the final product. Flow (kl/kkg) = 52.87 exp(0.017x), where x = percent sulfite pulp produced on-site in final product. Raw waste loads shown are for a mill where on-site papergrade pulp production is 58 percent of the total product.

effluent limitations through the application of activated sludge systems to treat the raw waste loads that form the basis of BPT effluent limitations for these four subcategories.) NSPS Option 1 and 2 final effluent loads are lower than BPT effluent limitations because, after implementation of in-plant production process controls which reduce wastewater flow, the detention time of the biological treatment system has been increased, thus reducing the load of BOD5 and TSS.

General Methodology. This option involves the determination of effluent characteristics based upon the capabilities of and technologies employed at "best performing" mills. Best performers were selected and attainable pollutant reductions were determined through a review of discharge monitoring reports (DMR) and long-term conventional pollutant data obtained as a result of the verification and the supplemental data request programs. These data are summarized in Tables VIII-4 through VIII-25.

The final effluent loads characteristic of the best performing mills in a subcategory form the basis of NSPS Option 1 BOD5 and TSS discharge characteristics for that subcategory. EPA has generally defined best performing mills as those mills where both the long-term average BOD5 and TSS effluent loads are equal to or less than the long-term average BOD5 and TSS BPT effluent limitations through implementation of end-of-pipe technology of a type that is similar to that which forms the basis of BPT. Generally, long-term average final effluent BOD5 and TSS discharges per kkg (ton) of product attained at best performing mills were averaged; corresponding concentrations of BOD5 and TSS were then determined at BPT flow. In those cases where Option 1 long-term average BOD5 effluent concentrations corresponding to BPT flow were less than 15 mg/l, the long-term average BOD5 concentration was revised upward to 15 mg/l. The Agency believes that 15 mg/l is a realistic estimate of the lowest attainable long-term average BOD5 concentration representative of the capability of biological treatment in treating pulp, paper, and paperboard industry wastewaters.

A description of the specific procedure used in establishing NSPS Option 1 effluent characteristics for each subcategory follows. As described, in some instances, EPA slightly modified the approach to determining "best performers."

Dissolving Kraft - As illustrated in Table VIII-4, the general methodology as described above was followed. BPT effluent limitations are being attained at mills 032002 and 032003.

Market Bleached Kraft - As illustrated in Table VIII-5, the general methodology was used to calculate NSPS Option 1 effluent characteristics for the market bleached kraft subcategory. Mills 030028, 030030, 030031, 666666, 777777, and 900074 in this subcategory are best performers and were used to determine long-term average final effluent loads. In addition to these mills, another mill (030011) was included in the calculation. At this integrated-miscellaneous mill

TABLE VIII-4
DISCHARGE MONITORING REPORT DATA
DISSOLVING KRAFT SUBCATEGORY

Mill Number	Final Effluent Long-Term Average Levels						Start Date	Number Of Months Data		
	Flow		BOD5		TSS					
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)		Flow	BOD5	TSS
032001	124.9	(29.94)	5.5	(10.92)	19.4	(38.81)	12/79	13	13	13
032002(a)	186.7	(44.74)	3.7	(7.47)	5.9	(11.71)	07/77	45	45	45
032003(a)	248.2	(59.48)	5.9	(11.80)	10.5	(20.95)	01/78	38	38	38
BPT-Final Effluent Levels	230.0	(55.1)	6.9	(13.8)	11.1	(22.1)				
Average of Mills Attaining BPT BOD5 and TSS			4.8	(9.64)	8.2	(16.33)				

(a) TSS and BOD5 are less than or equal to BPT.

TABLE VIII-5
DISCHARGE MONITORING REPORT DATA
MARKET BLEACHED KRAFT SUBCATEGORY

	Final Effluent Long-Term Average Levels						
Mill Number	Flow	BOD5	TSS	Start Date	Number Of Months Data		
	kl/kkg (kgal/t)	kg/kkg (lb/t)	kg/kkg (lb/t)		Flow	BOD5	TSS
030005	61.3 (14.68)	4.8 (9.65)	5.0 (9.97)	08/78	29	29	29
030009	76.4 (18.32)	6.2 (12.40)	4.8 (9.66)	01/78	39	39	39
030012	119.0 (28.52)	5.8 (11.60)	19.5 (39.03)	01/78	36	36	36
030028(a)	142.6 (34.18)	4.3 (8.55)	7.8 (15.65)	08/78	31	31	31
030030(a)	151.8 (36.38)	2.7 (5.41)	3.7 (7.37)	01/78	38	38	38
030031(a)	281.8 (67.53)	4.5 (8.94)	9.0 (18.03)	07/77	33	43	43
666666(a)	85.9 (20.59)	2.6 (5.16)	6.8 (13.57)	02/79	23	23	23
777777(a)	135.5 (32.46)	1.5 (3.08)	6.5 (12.98)	07/79	16	16	16
900074(a)	121.6 (29.13)	4.0 (7.94)	2.6 (5.16)	09/78	31	31	31
030011(a)(b)	140.4 (33.65)	3.6 (7.25)	3.7 (7.34)	08/78	21	21	21
BPT-Final Effluent Levels	173.0 (41.6)	4.5 (9.0)	9.0 (18.0)				
Average of Mills Attaining BPT BOD5 and TSS		3.3 (6.62)	5.7 (11.44)				

(a) TSS and BOD5 are less than or equal to BPT.

(b) This mill is an integrated miscellaneous mill where market bleached kraft comprises approximately 40 percent of the production. Prorated BPT was determined for this mill. The percent effluent BOD5 and TSS reductions being attained were then applied to BPT BOD5 and TSS effluent levels for the subcategory to obtain the effluent levels shown.

where BPT limits are being attained, bleached kraft pulp is produced, a significant portion of which is market pulp. The approach used to include data for this mill involved comparing BOD5 and TSS effluent loadings to BPT limitations determined by prorating limitations from appropriate subcategories. The percentage reductions attained at this mill were then applied to market bleached kraft BPT limitations. Effluent BOD5 and TSS characteristics for mill 030011 are 19.5 percent and 59.2 percent below prorated BPT limitations.

BCT (Paperboard, Coarse, and Tissue) Bleached Kraft - As illustrated in Table VIII-6, the general methodology was used to calculate NSPS Option 1 effluent characteristics for the BCT (paperboard, coarse, and tissue) bleached kraft subcategory. Mills 030010, 030022, and 030032 are best performers and were used to determine long-term average final effluent loads. In addition to these mills, two additional mills (030036 and 030044) were included in the calculation. At these integrated-miscellaneous mills where BPT limits are being attained, bleached kraft pulp is produced, a significant portion of which is used to manufacture paperboard, coarse papers, or tissue papers. The approach used to include data for these mills involved comparing BOD5 and TSS effluent loadings to BPT limitations determined by prorating limitations from appropriate subcategories. The percentage reductions attained at these two mills were then applied to the BCT (paperboard, coarse, and tissue) bleached kraft BPT limitations. Effluent BOD5 and TSS characteristics for mill 030036 are 32.2 and 4.7 percent below prorated BPT limitations while characteristics for 030044 are 68.0 and 40.1 percent below prorated BPT limitations.

Alkaline-Fine (Fine Bleached Kraft and Soda Subcategories) - As illustrated in Table VIII-7, the general methodology was used to calculate NSPS Option 1 effluent characteristics for the alkaline-fine mill grouping (bleached kraft fine and soda subcategories). Mills 030020, 030027, 030046, and 030052 were identified as best performing mills and were used to determine long-term average final effluent loads. In addition to these mills, two additional mills (030011 and 030044) were included in the calculation. At these integrated-miscellaneous mills where BPT limits are being attained, bleached kraft pulp is produced, a significant portion of which is used to produce fine papers. The approach used to include data for these mills involved comparing BOD5 and TSS effluent loadings to BPT limitations determined by prorating limitations from appropriate subcategories. The percentage reductions attained at these two mills were then applied to the fine bleached kraft BPT limitations. Effluent characteristics for these mills relative to prorated BPT limitations are discussed above.

Upon calculation of the concentration of BOD5 corresponding to the flow that formed the basis of BPT for the fine bleached kraft subcategory, EPA determined that the resulting BOD5 effluent concentration was below 15 mg/l. Therefore, the corresponding BOD5 effluent concentration and effluent load were revised upward as shown in Table VIII-7.

TABLE VIII-6
DISCHARGE MONITORING REPORT DATA
BCT BLEACHED KRAFT SUBCATEGORY

Mill Number	Final Effluent Long-Term Average Levels: Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)	Start Date	Number Of Months Data: Flow	BOD5	TSS
030004	208.0 (49.84)	4.6 (9.18)	4.2 (8.49)	10/78	28	28	28
030010(a)	170.9 (40.95)	2.5 (4.92)	4.3 (8.69)	07/77	43	43	43
030022(a)	150.0 (35.94)	3.9 (7.81)	1.8 (3.54)	01/78	39	39	39
030026	136.0 (32.59)	4.9 (9.73)	8.6 (17.25)	07/77	42	44	41
030032(a)	106.8 (25.60)	2.5 (5.09)	4.5 (8.95)	01/78	38	38	38
030047	151.7 (36.35)	5.4 (10.73)	4.3 (8.56)	10/78	25	25	25
900010	121.1 (29.02)	4.5 (9.03)	4.5 (9.03)	06/78	31	31	31
030036(a)(b)	129.8 (31.11)	2.7 (5.43)	6.8 (13.53)	07/77	33	33	33
030044(a)(b)	117.3 (28.12)	1.3 (2.56)	4.3 (8.50)	05/78	34	34	34
BPT-Final Effluent Levels	148.0 (35.4)	4.0 (8.0)	7.1 (14.2)				
Average of Mills Attaining BPT BOD5 and TSS		2.6 (5.16)	4.3 (8.64)				

(a) TSS and BOD5 are less than or equal to BPT.

(b) Mills are integrated miscellaneous mills where BCT bleached kraft comprise approximately 80 and 50 percent of the production, respectively. Prorated BPT was determined The percent effluent BOD5 and TSS reductions being attained were then applied to BPT BOD5 and TSS effluent levels for the subcategory to obtain the effluent levels shown.

TABLE VIII-7
DISCHARGE MONITORING REPORT DATA
ALKALINE-FINE[1]

Mill Number	Final Effluent Long-Term Average Levels: Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)	Start Date	Number Of Months Data: Flow	BOD5	TSS
030001	107.2 (25.69)	2.7 (5.47)	10.9 (21.82)	11/78	26	27	27
030013	138.4 (33.17)	2.7 (5.36)	8.5 (17.08)	01/78	27	35	34
030020(a)	112.3 (26.92)	1.3 (2.65)	2.5 (5.03)	12/78	24	24	24
030027(a)	63.4 (15.20)	0.7 (1.34)	2.1 (4.20)	04/78	33	33	33
030033	147.1 (35.24)	6.8 (13.68)	21.4 (42.73)	01/78	35	35	35
030034(a)(b)	69.6 (16.67)	1.0 (2.02)	2.7 (5.33)	10/79	18	18	18
030046(a)	137.6 (32.97)	2.1 (4.13)	3.1 (6.29)	07/77	27	27	27
030048	110.3 (26.44)	5.7 (11.48)	13.4 (26.89)	01/78	36	36	36
030052(a)	127.7 (30.59)	3.1 (6.16)	3.8 (7.58)	01/80	12	12	12
030058	124.0 (29.72)	4.1 (8.23)	7.4 (14.76)	07/77	33	33	33
030057	114.2 (27.37)	7.1 (14.24)	5.8 (11.55)	07/77	44	43	43
030059	143.4 (34.37)	2.7 (5.31)	11.2 (22.34)	05/78	36	36	36
030060	247.5 (59.32)	31.8 (63.60)	25.1 (50.28)	02/78	33	32	33
130002	70.1 (16.81)	2.3 (4.56)	8.5 (17.00)	07/78	18	18	18
030011(a)(c)	140.4 (33.66)	2.5 (4.99)	2.7 (5.34)	08/78	21	21	21
030044(a)(c)	117.3 (28.12)	1.0 (1.98)	3.9 (7.85)	05/78	34	34	34
BPT-Final Effluent Levels	129.0 (30.9)	3.1 (6.2)	6.6 (13.1)				
Average of Mills Attaining BPT BOD5 and TSS		1.8 (3.54)	3.5 (6.05)				
Option 1 Adjusted BOD5		1.9 (3.87)					

(a) TSS and BOD5 are less than or equal to BPT.

(b) Data are not included in the average because this mill employs tertiary chemically assisted clarification.

(c) Mills are integrated miscellaneous mills where fine papers comprise approximately 60 and 40 percent of the production, respectively. Prorated BPT was determined. The percent effluent BOD5 and TSS reductions being attained were then applied to BPT BOD5 and TSS effluent levels for the subcategory to obtain the effluent levels shown.

[1] Includes Fine Bleached Kraft and Soda subcategories.

Unbleached Kraft - As discussed previously, EPA has established two subdivisions of this subcategory: (a) the linerboard product sector and (b) the bag and other products product sector. EPA's review of the BPT final effluent characteristics for the unbleached kraft subcategory indicated that the final effluent BOD5 concentration that forms the basis of BPT for this subcategory is considerably higher for the linerboard product sector than for other subcategories with comparable raw waste BOD5 and, therefore, considerably underestimates the pollutant reduction capability in this sector. Therefore, to determine a more realistic set of best performing mills in the linerboard product sector, the BPT final effluent BOD5 load was revised downward based on the relationship of BOD5 influent to effluent presented previously and in the Phase II Development Document (see page 402).(48) Employing this methodology, the adjusted final effluent BOD5 long-term average load becomes 1.6 kg/kkg (3.2 lb/t).

After adjustment of the BOD5 final effluent load, the general methodology was followed for the linerboard product sector as illustrated in Table VIII-8. The mills in this product sector where revised final effluent loads are attained include mills 010002, 010019, 010020, 010025, 010040, and 010046. For the linerboard product sector, data for those mills with oxidation pond(s) (010020, 010025 and 010046) were excluded from the calculation.

As discussed in Section V, BOD5 raw waste loads for the bag and other products product sector are substantially higher than those that formed the basis of BPT effluent limitations. To determine a more realistic set of best performing mills for this product sector, EPA revised the BPT final effluent BOD5 load based on the relationship of BOD5 influent to effluent presented previously and in the Phase II Development Document (see page 402). (48) The Agency used the product sector average BOD5 raw waste load in this calculation. Employing this methodology, the final effluent BOD5 long-term average load was adjusted upward to 2.0 kg/kkg (4.0 lb/ton).

After adjustment of the BOD5 final effluent load, the general methodology was followed for the bag and other products product sector as illustrated in Table VIII-8. The mills in this product sector where revised final effluent loads are attained are mills 010006 and 010008.

Semi-Chemical - A review of the BPT final effluent characteristics for the semi-chemical subcategory indicates that the final effluent BOD5 concentration that forms the basis of BPT for this subcategory is considerably higher than for other subcategories with comparable raw waste BOD5 and, therefore, considerably underestimates the pollutant reduction capability in this sector. Therefore, to determine a more realistic set of best performing mills, the BPT final effluent BOD5 load was revised downward based on the relationship of BOD5 influent to effluent presented previously and in the Phase II Development Document (see page 402).(48) Employing this methodology, the adjusted final effluent BOD5 long-term average load becomes 1.9 kg/kkg (3.8 lb/t).

TABLE VIII-8
DISCHARGE MONITORING REPORT DATA
UNBLEACHED KRAFT SUBCATEGORY

Mill Number	Final Effluent Long-Term Average Levels			Start Date	Number Of Months Data		
	Flow	BOD5	TSS		Flow	BOD5	TSS
	kl/kkg (kgal/t)	kg/kkg (lb/t)	kg/kkg (lb/t)				
Linerboard							
010001	46.4 (11.12)	1.8 (3.50)	3.1 (6.14)	01/78	36	36	36
010002(a)	52.7 (12.64)	1.4 (2.88)	2.7 (5.44)	07/78	33	33	33
010018	54.8 (13.13)	3.1 (6.13)	3.5 (6.97)	10/78	11	11	11
010019(a)	49.8 (11.93)	1.1 (2.29)	2.7 (5.47)	09/77	36	36	36
010020(a)(b)	81.0 (19.41)	1.1 (2.21)	1.0 (1.99)	09/78	13	13	13
010025(a)(b)	43.0 (10.31)	0.5 (1.06)	0.6 (1.11)	09/78	31	31	31
010032	61.5 (14.74)	2.5 (4.99)	2.2 (4.30)	01/78	06	32	32
010033	68.1 (16.32)	1.9 (3.83)	0.4 (0.77)	07/77	29	29	29
010038	111.3 (26.66)	3.6 (7.21)	6.0 (11.98)	01/78	40	40	40
010040(a)	62.3 (14.93)	1.3 (2.54)	1.1 (2.20)	10/78	25	25	25
010043	42.6 (10.20)	0.7 (1.33)	5.0 (9.91)	06/79	20	22	22
010046(a)(b)	33.3 (7.97)	1.3 (2.65)	0.8 (1.69)	07/77	29	36	35
010047	22.0 (5.28)	1.9 (3.73)	0.9 (1.81)	07/77	38	38	38
010057	42.9 (10.27)	4.2 (8.46)	2.6 (5.24)	07/77	36	35	35
010063	29.3 (7.03)	2.6 (5.23)	5.3 (10.54)	06/78	34	34	34
010064	21.7 (5.19)	1.8 (3.54)	3.0 (6.02)	01/78	35	38	38
BPT-Final Effluent Levels	52.5 (12.6)	1.9 (3.7)	3.6 (7.2)				
BOD5 Comparison Level For NSPS		1.6 (3.2)					
Average of Mills Attaining BPT TSS and BOD5 Comparison Level		1.3 (2.57)	2.2 (4.37)				

TABLE VIII-8 (Continued)
DISCHARGE MONITORING REPORT DATA
UNBLEACHED KRAFT SUBCATEGORY

Mill Number	Final Effluent Long-Term Average Levels: Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)	Start Date	Number Of Months Data: Flow	BOD5	TSS
Bag Paper and Other Mixed Products							
010003	52.4 (12.56)	2.0 (4.01)	4.4 (8.77)	12/78	25	25	25
010005	64.1 (15.35)	2.1 (4.20)	3.3 (6.51)	06/79	22	22	22
010006(a)	54.5 (13.07)	2.0 (3.98)	3.0 (5.95)	07/77	42	42	42
010008(a)	43.3 (10.37)	1.0 (2.02)	2.5 (4.93)	07/77	23	39	39
010028	148.6 (35.61)	1.9 (3.83)	3.8 (7.50)	03/79	23	23	23
010034	84.8 (20.31)	2.3 (4.64)	3.4 (6.71)	01/78	37	37	37
010035	168.9 (40.48)	3.4 (6.80)	6.7 (13.35)	12/78	27	28	28
010044	57.5 (13.78)	1.6 (3.19)	5.4 (10.88)	09/78	24	24	24
010048(a)(c)	134.7 (32.28)	1.4 (2.72)	3.6 (7.22)	02/80	16	16	16
010055(a)(d)	42.9 (10.28)	1.5 (3.00)	2.4 (4.85)	06/80	07	07	07
010062	136.0 (32.60)	2.5 (4.92)	3.8 (7.67)	07/77	45	45	45
BPT-Final Effluent Levels	52.5 (12.6)	1.9 (3.7)	3.6 (7.2)				
BOD5 Comparison Level For NSPS		2.0 (4.0)					
Average of Mills Attaining BPT TSS and BOD5 comparison level		1.5 (3.00)	2.7 (5.44)				

(a) TSS is less than or equal to BPT; BOD5 is less than or equal to the BOD5 Comparison Level.
(b) Data are not included in the averages because treatment includes an oxidation pond.
(c) Data are not included in the averages because mill employs a two stage biological treatment system.
(d) Mill is not included in the averages because less than 12 months of data are available.

After adjustment of the BOD5 final effluent load, the general methodology was applied as illustrated in Table VIII-9. Mills in this subcategory where revised effluent limitations are attained include mills 060004, 020003, and 020009. In addition to these mills, two additional mills (020011 and 110068) which discharge to a joint treatment system were included in the calculation. A significant portion of the wastewater discharged to the joint treatment system is associated with the production of semi-chemical pulp. The approach used to include data for these mills involved comparing BOD5 and TSS effluent loads to BPT limitations determined by prorating limitations from appropriate subcategories. The percentage reductions attained at these mills were then applied to the revised semi-chemical BPT effluent limitations. Effluent BOD5 and TSS characteristics for mills 020011 and 110068 are 36.7 and 34.9 percent below prorated limitations.

Unbleached Kraft and Semi-Chemical - A review of the BPT final effluent characteristics for the unbleached kraft and semi-chemical subcategory indicates that the final effluent BOD5 concentration that forms the basis of BPT for this subcategory is considerably higher than for other subcategories with comparable raw waste BOD5 and, therefore, considerably underestimates the pollutant reduction capability in this sector. Therefore, to determine a more realistic set of best performing mills, the BPT final effluent BOD5 load was revised downward based on the relationship of BOD5 influent to effluent presented previously and in the Phase II Development Document (see page 402).(48) Employing this methodology, the adjusted final effluent BOD5 annual average load becomes 1.9 kg/kkg (3.7 lb/t).

After adjustment of the BOD5 effluent load, the general methodology was applied as illustrated in Table VIII-10. Mills where revised effluent limitations are attained include mills 015001 and 015004.

Papergrade Sulfite (Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories) - In reviewing this subcategory, as discussed in Sections IV and V, EPA determined that wastewater discharge is a function of the percentage of sulfite pulp manufactured on-site. In Section V, a mathematical relationship is presented based on mill data that relate wastewater flow to the percentage of sulfite pulp produced on-site. From this relationship, theoretical wastewater flows were obtained for each mill in the subcategory based on the percentage of sulfite pulp produced at each mill. Using the calculated wastewater flow and actual long-term average BOD5 and TSS final effluent loads for each mill, long-term average BOD5 and TSS final effluent concentrations were computed. These individual values were compared to BOD5 and TSS final effluent concentrations of 51 mg/l and 70 mg/l, respectively (the highest long-term average concentrations that formed the basis of BPT regulations for the two papergrade sulfite subcategories). Mills where the calculated final effluent concentrations are lower than 51 mg/l of BOD5 and 70 mg/l of TSS were selected as best performing mills. Five mills (040001, 040011, 040013, 040015, and 040019) were found to be best performers; however, as illustrated in Table VIII-11,

TABLE VIII-9
DISCHARGE MONITORING REPORT DATA
SEMI-CHEMICAL SUBCATEGORY

Mill Number	Final Effluent Long-Term Average Levels Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)	Start Date	Number Of Months Data Flow	BOD5	TSS
020001	26.1 (6.26)	3.1 (6.10)	4.5 (8.93)	12/77	20	20	20
020002	25.4 (6.08)	3.4 (6.88)	3.7 (7.49)	07/78	29	29	29
020003(a)	40.5 (9.71)	0.4 (0.71)	1.5 (2.95)	04/78	25	25	25
020004(a)(b)	24.4 (5.84)	1.4 (2.80)	0.6 (1.29)	01/78	39	39	39
020006	13.6 (3.26)	2.7 (5.41)	4.4 (8.89)	05/78	36	36	36
020007	11.2 (2.69)	3.1 (6.28)	3.1 (6.11)	07/77	27	23	23
020008(a)(c)	11.7 (2.80)	1.1 (2.11)	2.2 (4.30)	08/78	28	28	28
020009(a)	28.5 (6.84)	1.9 (3.80)	3.4 (6.75)	10/78	27	26	27
020010	23.6 (5.65)	2.0 (3.94)	3.3 (6.51)	10/78	30	30	30
020011(a)(d)	17.6 (4.22)	1.2 (2.40)	2.6 (5.27)	11/78	27	28	28
020012	31.5 (7.55)	3.7 (7.46)	6.4 (12.76)	07/77	44	43	43
020014	26.5 (6.35)	3.8 (7.54)	7.1 (14.10)	07/78	30	30	30
020015	34.5 (8.27)	11.1 (22.13)	11.8 (23.67)	06/79	22	22	22
020016	37.9 (9.09)	2.6 (5.19)	4.6 (9.25)	06/80	07	07	07
020017	18.7 (4.47)	2.5 (4.99)	2.7 (5.36)	07/78	29	29	29
060004(a)	36.9 (8.85)	1.3 (2.53)	1.3 (2.61)	10/78	27	27	27
900011	49.8 (11.94)	4.3 (8.54)	6.4 (12.85)	08/77	33	31	31
BPT-Final Effluent Level	42.9 (10.3)	3.2 (6.4)	4.1 (8.1)				
BOD5 Comparison Level For NSPS		1.9 (3.8)					
Average of Mills Attaining BPT TSS and BOD5 Comparison Level		1.2 (2.36)	2.2 (4.40)				

(a) TSS is less than or equal to BPT; BOD5 is less than or equal to the BOD5 Comparison Level.

(b) Data are not included in the average because mill employs reverse osmosis.

(c) Data are not included in the average because this mill occasionally spray irrigates some effluent.

(d) This semi-chemical mill shares a joint treatment system with a paperboard from wastepaper mill. It contributes approximately 46 percent of the total production of both mills. Prorated BPT was determined. The percent effluent BOD5 and TSS reductions being attained were then applied to the BPT TSS effluent level and BOD5 comparison level for the subcategory to obtain the effluent levels shown.

TABLE VIII-10
DISCHARGE MONITORING REPORT DATA
UNBLEACHED KRAFT AND SEMI-CHEMICAL SUBCATEGORY

Mill Number	Final Effluent Long-Term Average Levels: Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)	Start Date	Number Of Months Data: Flow	BOD5	TSS
010017	37.3 (8.94)	2.6 (5.23)	4.1 (8.25)	03/78	34	34	34
015001(a)	43.6 (10.46)	1.9 (3.70)	3.1 (6.19)	01/78	39	39	39
015002(b)	36.3 (8.70)	1.7 (3.32)	3.8 (7.50)	09/77	42	41	41
015003	41.4 (9.91)	3.9 (7.78)	2.7 (5.39)	01/78	40	40	40
015004(a)	52.9 (12.68)	0.9 (1.70)	1.6 (3.20)	06/79	13	13	13
015005	36.7 (8.80)	2.4 (4.84)	1.6 (3.14)	01/78	32	32	32
015006	47.6 (11.41)	3.3 (6.69)	4.3 (8.64)	01/78	38	38	38
015007	56.3 (13.48)	2.1 (4.14)	5.1 (10.18)	10/78	29	29	29
015009(c)	51.0 (12.23)	4.8 (9.55)	5.2 (10.38)	07/77	18	18	18
BPT-Final Effluent Levels	58.4 (14.0)	3.0 (5.9)	3.6 (7.1)				
BOD5 Comparison Level For NSPS		1.9 (3.7)					
Average of Mills Attaining BPT TSS and BOD5 Comparison Level		1.4 (2.70)	2.4 (4.70)				

(a) TSS is less than or equal to BPT; BOD5 is less than or equal to BOD5 Comparison Level.

(b) Mill discharges some effluent to percolation ponds in the summer. Data are not representative of entire effluent discharge.

(c) Mill now produces bleached kraft products. Data presented are for the period prior to addition of bleaching processes.

TABLE VIII-11
DISCHARGE MONITORING REPORT DATA
PAPERGRADE SULFITE SUBCATEGORY

Mill Number	Final Effluent Long-Term Average Levels: Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)	Start Date	Number Of Months Data: Flow	BOD5	TSS
040001(a)(e)	123.3 (29.55)	10.7 (21.30)	9.1 (18.10)	07/77	32	34	35
040002	305.3 (73.16)	14.9 (29.86)	25.4 (50.78)	07/79	19	21	21
040008(b)	219.1 (52.51)	10.3 (20.52)	12.4 (24.89)	07/80	9	9	9
040010(c)	258.3 (61.90)	6.4 (12.72)	6.1 (12.15)	07/77	46	46	45
040011(d)(e)	60.9 (14.60)	1.4 (2.89)	2.5 (4.92)	04/80	14	14	14
040012	258.1 (61.85)	11.1 (22.21)	14.2 (28.30)	07/77	31	33	32
040013(e)	100.9 (24.17)	4.5 (8.95)	7.4 (14.88)	11/79	17	17	17
040015(e)	40.1 (9.62)	12.3 (24.68)	12.7 (25.34)	06/78	36	36	36
040016	116.4 (27.89)	6.5 (13.07)	14.9 (29.74)	06/77	35	16	44
040017	84.3 (20.21)	5.3 (10.57)	10.0 (20.09)	07/77	45	45	45
040018(f)	85.7 (20.53)	1.8 (3.61)	1.7 (3.48)	07/77	27	27	27
040019(e)(g)	45.3 (10.86)	2.8 (5.66)	3.5 (7.09)	06/79	19	19	19
040009(e)(h)	89.3 (21.41)	1.5 (2.95)	4.8 (9.66)	09/79	21	21	21

BPT final effluent levels are based on the processes used to manufacture sulfite pulp.

	Flow	BOD5	TSS
NSPS Comparison Levels	*	51 mg/l	70 mg/l
Calculated Comparison Level Flows and Theoretical Concentrations(i):			
040013	137.0 (32.83)	32.69 mg/l	54.35 mg/l
040015	289.4 (69.35)	42.67 mg/l	43.81 mg/l
040019	128.0 (30.67)	22.13 mg/l	27.72 mg/l
Average Concentration		32.5 mg/l	42.0 mg/l

Option 1 Long-Term Average Final Effluent Levels:

BOD5 (kg/kkg) = 1.72 exp (0.017x)
TSS (kg/kkg) = 2.22 exp (0.017x)
Where x equals the percent sulfite pulp produced on-site.

(a) Data are not considered in the average because pulp is not bleached at this mill. Mill is now closed.
(b) Data are not considered in the average because less than 12 months data are available.
(c) Data are not considered in the average because glassine papers are produced at this mill which is not typical of the subcategory.
(d) Data are not considered in the average because mill employs a 2-stage biological treatment system.
(e) Theoretical concentrations are below the NSPS comparison levels.
(f) Pulp mill wastes are discharged to a POTW.
(g) A portion of the wastewater discharge is not treated in the biological treatment system.
(h) This papergrade sulfite mill shares a joint treatment system with an alkaline-fine mill. It contributes approximately 48 percent of the total production of both mills. Prorated BPT was calculated and this mill was found to meet BPT levels. Data for this mill were not considered in the averages as the final effluent is not typical of the subcategory.
(i) The theoretical concentration is equal to the long-term average (lb/t) divided by (the theoretical comparison level flow for the mill times 0.00834 lb/kgal).

* Comparison Level flow is based on the following equation relating flow (kgal/t) to percent sulfite pulp (x) (produced on-site) in the final product, with theoretical concentrations calculated using this equation and the annual average discharge levels reported above for each mill:

$\text{Flow (kgal/t)} = 12.67e^{0.017x}$
$\text{Flow (kl/kkg)} = 52.87e^{0.017x}$

mill 040011 was excluded from the calculation because its treatment system, a two stage biological system, is not considered to be sufficiently representative of the technology on which BPT is based. Mill 040001 was also excluded from the calculation because pulp is not bleached at this mill.

Long-term average NSPS Option 1 loads were calculated as the product of the average of the long-term average concentrations of the three mills which were found to be best performers, and the flow corresponding to that calculated from the relationship shown in the footnote to Table VIII-11. The flow and, therefore, the long-term average NSPS Option 1 loads will vary from mill to mill depending on the percentage of sulfite pulp produced at a given mill.

Dissolving Sulfite Pulp - As no best performing mills have been identified in the dissolving sulfite pulp subcategory, the Agency relied on transfer of mill performance in the papergrade sulfite subcategories to determine long-term final effluent loads. NSPS Option 1 effluent loads were determined by applying the following methodology:

a. The average TSS reduction of 40.0 percent for the papergrade sulfite subcategories has been transferred directly to the dissolving sulfite pulp subcategory.

b. The long-term average $BOD\underline{5}$ effluent concentrations that formed the basis of BPT for papergrade sulfite mills 040013, 040015, and 040019 are 42, 50, and 47 mg/l, respectively. These concentrations and the flow relationship shown in the footnote on Table VIII-11 were used to determine a baseline $BOD\underline{5}$ long-term average load for each mill.

c. The percentage reduction of $BOD\underline{5}$ discharge at mills 040013, 040015, and 040019 were compared to the baseline calculated in "b" above.

d. This reduction of 29.9 percent was applied to each product sector of the dissolving sulfite pulp subcategory to yield the NSPS Option 1 long-term average $BOD\underline{5}$ loads.

Table VIII-12 illustrates the calculation of NSPS Option 1 long-term average loads and presents available discharge data for the dissolving sulfite pulp subcategory. EPA has determined that the characteristics and treatability of wastewaters discharged from mills in the dissolving sulfite pulp and the papergrade sulfite subcategories are similar. In fact, BPT effluent limitations for both subcategories were developed from the same relationship between $BOD\underline{5}$ raw waste concentrations and $BOD\underline{5}$ final effluent concentrations.(48) Therefore, the Agency believes that new dissolving sulfite pulp mills will be able to attain the long-term average discharge characteristics presented in Table VIII-12.

TABLE VIII-12
DISCHARGE MONITORING REPORT DATA
DISSOLVING SULFITE PULP SUBCATEGORY

Mill Number	Final Effluent Long-Term Average Levels: Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)	Start Date	Number Of Months Data: Flow	BOD5	TSS
046001	224.0 (53.68)	35.4 (70.86)	22.4 (44.74)	07/77	41	43	43
046002	397.0 (95.14)	47.6 (95.17)	42.3 (84.59)	01/79	26	26	26
046003	277.5 (66.50)	40.1 (80.26)	11.9 (23.74)	12/80	7	7	7
046004(a)	174.5 (41.82)	10.3 (20.68)	28.9 (57.86)	04/79	18	18	17
046005	352.5 (84.47)	41.1 (82.28)	51.7 (103.32)	11/79	14	14	14
046006	135.0 (32.36)	26.2 (52.30)	14.2 (28.40)	07/77	42	42	42
BPT final effluent levels depend on grade of pulp manufactured, as follows:							
Nitration	275.0 (66.0)	12.1 (24.2)	20.9 (41.8)				
Viscose	275.0 (66.0)	13.0 (25.9)	20.9 (41.8)				
Cellophane	275.0 (66.0)	14.1 (28.1)	20.9 (41.8)				
Acetate	303.4 (72.7)	17.8 (35.5)	20.9 (41.8)				
Basis for Determining NSPS Comparison Levels(b)							
040013		42 mg/l	70 mg/l				
040015		50 mg/l	70 mg/l				
040019		47 mg/l	70 mg/l				
Average Percentage Below Comparison Level to be Applied to Dissolving Sulfite Pulp Subcategory(c)		29.9	40.0				
Option 1 long-term average final effluent levels depend on grade of pulp manufactured, as follows:							
Nitration	8.5 (16.96)	12.5 (25.08)					
Viscose	9.1 (18.15)	12.5 (25.08)					
Cellophane	9.9 (19.70)	12.5 (25.08)					
Acetate	12.4 (24.88)	12.5 (25.08)					

(a) This mill shares a joint treatment system with a paper mill.

(b) Concentrations are those forming the basis of BPT for these papergrade sulfite mills and are process-dependent.

(c) These are the average percentages below BPT concentration bases (reported above) of the theoretical concentrations shown on Table VIII-11.

Groundwood-Thermo-Mechanical - As illustrated in Table VIII-13, the general methodology was followed; BPT effluent limitations are being attained at mill 070001.

Groundwood-Fine Papers - As illustrated in Table VIII-14, the general methodology was followed. BPT effluent limitations are being attained at mills 052003, 052007, 052008, 052014, and 054014. In addition to these mills, another mill (052009) was included in the calculation. At this integrated miscellaneous mill where BPT effluent limitations are attained, groundwood pulp is produced, a significant portion of which is used to manufacture fine papers. The approach used to include data for this mill involved comparing $BOD\underline{5}$ and TSS effluent loadings to BPT limitations determined by prorating limitations from appropriate subcategories. The percentage reductions attained at this mill were then applied to groundwood-fine papers BPT limitations. Effluent $BOD\underline{5}$ and TSS characteristics for mill 052009 are 14.6 percent and 26.5 percent below prorated BPT limitations.

Upon calculation of the concentration of $BOD\underline{5}$ corresponding to the flow that forms the basis of BPT for the groundwood-fine papers subcategory, EPA determined that the resulting $BOD\underline{5}$ effluent concentration was below 15 mg/l. Therefore, the corresponding long-term average $BOD\underline{5}$ effluent concentration and effluent load were revised upward as shown in Table VIII-14.

Groundwood-CMN Papers - As illustrated in Table VIII-15, the general methodology was followed in establishing BPT effluent limitations. At mill 054015, BPT effluent limitations are attained. For the nine month period prior to December 1978, the long-term average TSS for this mill was 2.2 kg/kkg (4.4 lb/t). In November 1978, the NPDES authority increased the allowable TSS discharge. For the period after November 1978, the long-term average TSS is 5.2 kg/kkg (10.4 lb/t). This mill has demonstrated that 2.2 kg/kkg (4.4 lb/t) can be attained. Therefore, the long-term TSS effluent load is based on performance at mill 054015 prior to December 1978.

Upon calculation of the concentration of $BOD\underline{5}$ corresponding to the flow that forms the basis of BPT for the groundwood-CMN papers subcategory, EPA determined that the resulting $BOD\underline{5}$ effluent concentration was below 15 mg/l. Therefore, the corresponding long-term average $BOD\underline{5}$ effluent concentration and effluent load were revised upward as shown in Table VIII-15.

Deink - As shown in Table VIII-16, three product sectors have been considered: fine papers, tissue papers, and newsprint.

For the deink-fine papers product sector, the general methodology was followed. BPT effluent limitations are being attained at mills 140007, 140008, and 140019.

For the deink-tissue papers product sector, the general methodology was followed, although mills 140018 and 140030 were not included in the calculation of attainable effluent levels. Mill 140018 was

TABLE VIII-13
DISCHARGE MONITORING REPORT DATA
GROUNDWOOD-THERMO-MECHANICAL SUBCATEGORY

	Final Effluent Long-Term Average Levels						
Mill Number	Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)	Start Date	Number Of Months Data Flow	Number Of Months Data BOD5	Number Of Months Data TSS
070001(a)	87.9 (21.07)	1.6 (3.18)	2.7 (5.45)	05/79	20	20	20
070002	33.8 (8.10)	3.6 (7.29)	6.2 (12.38)	06/79	22	22	22
BPT-Final Effluent Levels	88.0 (21.1)	3.1 (6.2)	4.6 (9.2)				
BOD5 Comparison Level for NSPS		2.3 (4.5)					
Average of Mills Attaining BPT TSS and BOD5 Comparison Level		1.6 (3.18)	2.7 (5.45)				

(a) TSS is less than or equal to BPT; BOD5 is less than or equal to the BOD5 Comparison Level.

TABLE VIII-14
DISCHARGE MONITORING REPORT DATA
GROUNDWOOD-FINE PAPERS SUBCATEGORY

Mill Number	Final Effluent Long-Term Average Levels			Start Date	Number Of Months Data		
	Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)		Flow	BOD5	TSS
052003(a)	71.6 (17.16)	0.8 (1.64)	3.0 (5.94)	08/77	8	41	41
052004	53.8 (12.89)	2.2 (4.47)	3.1 (6.11)	09/77	45	45	45
052007(a)	78.7 (18.87)	0.9 (1.87)	2.6 (5.14)	01/78	38	38	38
052008(a)	41.3 (9.89)	0.4 (0.87)	1.3 (2.53)	01/78	36	36	33
052009(a)(b)	78.5 (18.82)	1.7 (3.41)	2.5 (5.07)	07/77	37	30	30
052014(a)	37.1 (8.89)	0.3 (0.57)	0.4 (0.74)	02/78	39	39	40
054014(a)	35.6 (8.52)	1.3 (2.50)	2.3 (4.61)	05/78	33	33	33
BPT-Final Effluent Levels	91.0 (21.9)	2.0 (4.0)	3.5 (6.9)				
Average of Mills Attaining BPT BOD5 and TSS		0.9 (1.81)	2.0 (4.01)				
Option 1 Adjusted BOD5		1.4 (2.74)					

(a) TSS and BOD5 are less than or equal to BPT.

(b) Mill is an integrated miscellaneous mill where groundwood-fine papers comprise approximately 66 percent of the production. Prorated BPT was determined. The percent effluent BOD5 and TSS reductions being attained were then applied to BPT BOD5 and TSS effluent levels for the subcategory to obtain the effluent levels shown.

TABLE VIII-15
DISCHARGE MONITORING REPORT DATA
GROUNDWOOD-CMN PAPERS SUBCATEGORY

	Final Effluent Long-Term Average Levels						
Mill	Flow	BOD5	TSS	Start	Number Of Months Data		
Number	kl/kkg (kgal/t)	kg/kkg (lb/t)	kg/kkg (lb/t)	Date	Flow	BOD5	TSS
052015	69.0 (16.53)	3.8 (7.68)	2.8 (5.57)	01/78	24	25	25
054015(a)(b)	109.5 (26.25)	1.0 (1.99)	2.2 (4.41)	01/78	9	9	11
054015(b)	112.2 (26.89)	1.2 (2.48)	5.2 (10.44)	12/78	25	25	25
BPT-Final Effluent Levels	99.0 (23.8)	2.2 (4.4)	3.8 (7.5)				
Average of Mills Attaining BPT BOD5 and TSS		1.2 (2.35)(b)	2.2 (4.41)				
Option 1 Adjusted BOD5		1.5 (2.98)					

(a) TSS and BOD5 are less than or equal to BPT.

(b) Mill operated at the lower effluent levels listed above until their permitted TSS limits were relaxed, after which it operated at the higher levels. Long-term average BOD5 was determined by averaging data over the entire period for which there are DMR data (weighted average of the two periods).

TABLE VIII-16
DISCHARGE MONITORING REPORT DATA
DEINK SUBCATEGORY

Mill Number	Final Effluent Long-Term Average Levels: Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)	Start Date	Number Of Months Data: Flow	BOD5	TSS
Fine Papers							
140007(a)	48.0 (11.50)	2.2 (4.37)	4.0 (8.00)	03/78	39	39	39
140008(a)	55.5 (13.29)	3.2 (6.45)	3.2 (6.43)	07/77	46	46	46
140019(a)	31.2 (7.48)	2.0 (3.98)	3.8 (7.50)	07/77	44	43	44
BPT-Final Effluent Levels	102.0 (24.4)	5.3 (10.6)	7.1 (14.2)				
Average of Mills Attaining BPT BOD5 and TSS		2.5 (4.93)	3.7 (7.31)				
Newsprint							
900017(a)(b)	56.1 (13.44)	1.4 (2.82)	1.1 (2.18)	01/80	15	15	15
BPT Final Effluent Levels	102.0 (24.4)	5.3 (10.6)	7.1 (14.2)				
Tissue Papers							
140014(a)	84.3 (20.20)	4.4 (8.75)	7.1 (14.14)	07/77	44	44	44
140015(a)	94.6 (22.67)	3.4 (6.84)	4.7 (9.43)	11/77	43	43	43
140018(a)(c)	17.6 (4.22)	3.1 (6.20)	1.4 (2.84)	12/79	10	9	10
140021(a)	100.1 (23.99)	2.2 (4.40)	4.1 (8.16)	09/77	42	42	42
140022	108.7 (26.06)	12.4 (24.75)	5.1 (10.16)	03/79	26	26	26
140024	7.9 (1.90)	12.1 (24.14)	7.2 (14.40)	07/77	44	44	44
140025(a)	57.9 (13.87)	4.3 (8.68)	4.5 (8.92)	04/78	26	26	26
140030(a)(d)	68.1 (16.33)	2.0 (3.91)	2.5 (5.05)	07/77	45	47	47
900015(a)	39.4 (9.43)	2.3 (4.53)	2.3 (4.53)	02/79	22	22	22
900018	55.0 (13.18)	8.1 (16.25)	2.7 (5.40)	07/77	29	45	45
900020	134.4 (32.20)	9.1 (18.26)	15.4 (30.76)	01/79	24	24	24
BPT-Final Effluent Levels	102.0 (24.4)	5.3 (10.6)	7.1 (14.2)				
Average of Mills Attaining BPT BOD5 and TSS		3.3 (6.64)	4.5 (9.04)				

(a) TSS and BOD5 are less than or equal to BPT.

(b) This mill employs chemically assisted secondary clarification. Data were not used in developing NSPS Option I final effluent loads.

(c) Data are not included in the average because less than 12 months data are available.

(d) Data are not included in the average because only a small percentage of deinked pulp is produced.

eliminated because insufficient data were available; mill 140030 was eliminated because of a very low on-site production of deinked pulp. Mills 140014, 140015, 140021, 140025, and 900015 are included in the calculation of long-term effluent loads.

At the time of promulgation of BPT effluent limitations for the deink subcategory, there were no direct discharging deink mills where newsprint was produced. Now there is only one direct discharging mill in the deink-newsprint product sector. It is not appropriate to base NSPS Option 1 effluent loads for this product sector on the performance of this mill because the end-of-pipe treatment technology employed is more advanced than that identified as BPT for this subcategory.

The manufacture of newsprint from deinked newsprint is a relatively new papermaking process. Flow and BOD5 raw waste loads at deink-newsprint mills are considerably lower than those that formed the basis of BPT effluent limitations for the deink subcategory. EPA determined NSPS Option 1 final effluent loads based on the predicted performance of biological treatment applied to the deink-newsprint sector average BOD5 raw waste concentration. This methodology is described in detail previously in this section in the discussions of the best practicable control technology currently available. NSPS Option 1 long-term average BOD5 and TSS effluent loads were calculated as the product of the long-term average final effluent concentrations and the average flow for the product sector.

Tissue from Wastepaper - In the tissue from wastepaper subcategory, extensive use of production process controls to reduce wastewater discharge is practiced. NSPS Option 1 for this subcategory is identical to NSPS Option 2 and includes the application of production process controls and biological treatment. The methodology for development of long-term average effluent characteristics is described in detail later in this section (see NSPS Option 2). Available effluent data for mills in this subcategory are presented in Table VIII-17.

Paperboard from Wastepaper - In the paperboard from wastepaper subcategory, extensive use of production process controls to reduce wastewater discharge is practiced. NSPS Option 1 for this subcategory is identical to NSPS Option 2 and includes the application of production process controls and biological treatment. The methodology for development of long-term average effluent characteristics for both subdivisions of this subcategory is described in detail later in this section (see NSPS Option 2). Available effluent data for mills in both subdivisions of this subcategory are presented in Table VIII-18.

Wastepaper-Molded Products - In the wastepaper-molded products subcategory, extensive use of production process controls to reduce wastewater discharge is practiced. NSPS Option 1 for this subcategory is identical to NSPS Option 2 and includes the application of production process controls and biological treatment. The methodology for development of long-term average effluent characteristics is

TABLE VIII-17
DISCHARGE MONITORING REPORT DATA
TISSUE FROM WASTEPAPER SUBCATEGORY(a)

Mill Number	Final Effluent Long-Term Average Levels: Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)	Start Date	Number Of Months Data: Flow	BOD5	TSS
085004(g)	44.1 (10.57)	1.8 (3.63)	2.0 (4.08)	02/78	38	38	38
090002(b)(g)	40.5 (9.70)	3.3 (6.52)	1.4 (2.86)	07/77	33	32	33
090004(g)	53.7 (12.86)	3.7 (7.36)	1.9 (3.82)	07/77	38	38	38
090010(c)(g)	91.9 (22.03)	1.2 (2.38)	0.8 (1.59)	07/77	43	43	42
090014(d)	92.4 (22.15)	5.8 (11.58)	3.6 (7.17)	03/79	25	25	25
100001(e)	98.8 (23.68)	5.3 (10.52)	10.6 (21.24)	07/77	38	39	39
100005(g)	29.4 (7.05)	1.8 (3.69)	1.3 (2.56)	09/77	41	42	29
100013(g)	38.9 (9.31)	1.7 (3.44)	3.3 (6.50)	07/78	33	31	33
100014(f)(g)	3.9 (0.94)	1.3 (2.53)	0.3 (0.63)	07/77	14	14	14
100016(d)	226.8 (54.35)	35.0 (70.02)	106.1(212.15)	01/78	37	38	38
BPT-Final Effluent Levels	105.2 (25.2)	4.0 (8.0)	5.1 (10.1)				

(a) NSPS Option 1 final effluent levels are the same as those determined for NSPS Option 2.
(b) Mill has no external treatment.
(c) These data are representative of one 4-hour composite sample per month.
(d) This mill employs primary treatment only.
(e) Since 7/79 this mill has been required to monitor BOD5 only once per month and TSS only once per 4 months.
(f) This mill employed primary treatment only. The mill is now closed.
(g) TSS and BOD5 are less than or equal to BPT.

TABLE VIII-18
DISCHARGE MONITORING REPORT DATA
PAPERBOARD FROM WASTEPAPER SUBCATEGORY(a)

Mill	Final Effluent Long-Term Average Levels Flow		BOD5		TSS		Start	Number Of Months Data		
Number	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)	Date	Flow	BOD5	TSS
Noncorrugating Medium Furnish										
110001(b)(i)	20.7	(4.96)	0.1	(0.27)	0.3	(0.67)	07/77	37	36	38
110019(i)	29.9	(7.16)	1.0	(1.97)	1.1	(2.28)	08/77	25	33	38
110020	35.8	(8.57)	0.8	(1.66)	1.4	(2.79)	08/77	41	42	42
110022(b)	68.1	(16.31)	1.7	(3.46)	2.2	(4.45)	01/78	20	20	20
110023	11.9	(2.85)	1.3	(2.58)	1.3	(2.62)	07/77	45	45	45
110031(i)	7.6	(1.83)	0.1	(0.27)	0.2	(0.38)	07/77	42	41	42
110032(c)(i)	25.8	(6.18)	0.9	(1.76)	1.1	(2.21)	04/78	34	35	35
110034(i)	6.0	(1.44)	1.1	(2.11)	0.8	(1.56)	05/79	22	16	17
110043(i)	17.1	(4.09)	0.8	(1.56)	1.2	(2.32)	07/77	29	43	43
110052(i)	23.8	(5.71)	0.4	(0.77)	0.5	(1.02)	09/77	13	13	13
110060(d)	2.6	(0.63)	2.2	(4.45)	0.2	(0.36)	04/78	16	16	16
110061(e)(i)	19.6	(4.69)	0.8	(1.58)	1.1	(2.28)	07/77	46	46	46
110062(i)	10.4	(2.49)	0.5	(1.09)	0.6	(1.21)	01/79	27	27	27
110067(i)	15.4	(3.69)	0.4	(0.86)	0.8	(1.63)	07/78	29	30	30
110069(i)	29.3	(7.01)	0.2	(0.46)	0.7	(1.48)	01/79	24	25	25
110070(i)	18.7	(4.49)	0.3	(0.57)	0.3	(0.52)	07/77	43	43	40
110074(i)	3.8	(0.91)	0.1	(0.24)	0.3	(0.62)	09/78	30	30	30
110077(i)	2.3	(0.54)	0.2	(0.33)	0.2	(0.41)	01/78	15	15	15
110080	32.6	(7.82)	2.8	(5.62)	2.8	(5.57)	01/80	14	14	14
110094(i)	21.8	(5.23)	0.5	(0.95)	0.7	(1.35)	07/77	45	45	45
110096(i)	---	(f)	0.1	(0.15)	0.0	(0.04)	10/78	27	27	27
110100(d)(g)	---	---	4.4	(8.83)	1.5	(3.04)	05/78	0	8	8
110103(c)(i)	18.5	(4.44)	0.2	(0.35)	0.3	(0.66)	02/79	26	26	26
110104(h)(i)	1.0	(0.23)	1.1	(2.27)	0.4	(0.70)	01/79	24	27	27
110110(i)	4.9	(1.18)	0.2	(0.39)	0.8	(1.61)	04/79	25	25	25
110113(i)	17.3	(4.14)	0.8	(1.69)	1.6	(3.22)	07/77	46	46	46
110119	12.1	(2.91)	2.7	(5.34)	0.5	(0.93)	07/78	9	21	21

TABLE VIII-18 (Continued)
DISCHARGE MONITORING REPORT DATA
PAPERBOARD FROM WASTEPAPER SUBCATEGORY

Mill Number	Final Effluent Long-Term Average Levels: Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)	Start Date	Number Of Months Data: Flow	BOD5	TSS
110127	12.6 (3.02)	0.9 (1.81)	0.8 (1.50)	07/77	34	34	34
110131(b)(h)	16.2 (3.88)	4.9 (9.82)	1.1 (2.23)	01/78	24	21	21
110134	11.2 (2.69)	1.7 (3.31)	2.4 (4.82)	10/78	27	27	27
110141(e)	8.0 (1.92)	1.5 (2.99)	0.6 (1.12)	07/77	39	42	42
110144	8.5 (2.04)	1.6 (3.23)	1.3 (2.54)	01/80	16	16	16
110147	6.0 (1.43)	1.7 (3.35)	1.4 (2.82)	07/77	25	25	26
110151(i)	15.7 (3.76)	1.2 (2.45)	0.9 (1.72)	07/77	9	9	9
900023(c)(i)	28.4 (6.80)	0.3 (0.62)	0.4 (0.74)	07/77	45	44	44
900024(g)(i)	2.1 (0.50)	0.0 (0.08)	0.1 (0.12)	10/77	36	33	33
900026(i)	34.2 (8.20)	0.1 (0.24)	0.8 (1.52)	02/79	19	20	20
BPT-Final Effluent Levels	30.0 (7.2)	0.9 (1.7)	1.2 (2.3)				
Corrugating Medium Furnish							
110025(i)	7.6 (1.82)	0.8 (1.67)	1.5 (3.04)	03/79	21	21	21
110054	58.6 (14.05)	1.7 (3.35)	0.4 (0.88)	07/78	12	12	12
110057(i)	6.7 (1.60)	0.9 (1.71)	0.6 (1.23)	07/77	46	46	46
BPT-Final Effluent Levels	30.0 (7.2)	1.6 (3.1)	2.1 (4.2)				

(a) NSPS Option 1 final effluent levels are the same as those determined for NSPS Option 2.
(b) Mill is now closed.
(c) Biological treatment is followed by sand filtration.
(d) Mill is scheduled to discharge to a POTW.
(e) This mill spray irrigates a portion of its final effluent; data presented are not representative of total discharge.
(f) Flows are generally less than 0.005 kgal/ton.
(g) Mill has no external treatment system.
(h) Mill has primary treatment only.
(i) BOD5 and TSS are less than or equal to prorated BPT for this mill. Prorated BPT has been determined for each mill based on the percent corrugated medium furnish employed by the mill.

described in detail later in this section (see NSPS Option 2). Available effluent data for mills in this subcategory are presented in Table VIII-19.

Builders' Paper and Roofing Felt - In the builders' paper and roofing felt subcategory, extensive use of production process controls to reduce wastewater discharge is practiced. NSPS Option 1 for this subcategory is identical to NSPS Option 2 and includes the application of production process controls and biological treatment. The methodology for development of long-term average effluent characteristics is described in detail later in this section (see NSPS Option 2). Available effluent data for mills in this subcategory are presented in Table VIII-20.

Nonintegrated-Fine Papers - Two subcategory subdivisions have been considered: wood fiber furnish and cotton fiber furnish.

For the wood fiber furnish subdivision of the nonintegrated-fine papers subcategory, as illustrated in Table VIII-21, the general methodology was followed; however, data relating to mills where only primary treatment is employed were excluded from the computations. Data were reviewed with respect to waste significant grade changes. No significant difference due to grade change was noted and the combined data were used. BPT effluent limitations are attained through the application of biological treatment at mills 080007, 080027, 080041, and 080046. Mill 080027 was also excluded from the calculations because chemically assisted clarification is employed at that mill.

For the cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory, EPA determined NSPS Option 1 effluent loads based on the transfer of the performance of biological treatment characteristic of the wood fiber furnish subdivision. EPA applied the average percent reduction for BOD_5 and TSS from the best performing mills in the wood fiber furnish subdivision (41.0 percent for BOD_5 and 51.1 percent for TSS) to BPT final effluent loads for the cotton fiber furnish subdivision. EPA determined that the characteristics and treatability of wastewaters discharged from mills in both subcategory subdivisions are similar. Therefore, the Agency believes that new mills in the cotton fiber furnish subdivision will be able to attain the NSPS Option 1 long-term average discharge characteristics. Available effluent data for mills in this subdivision of the nonintegrated-fine papers subcategory are presented in Table VIII-21.

Nonintegrated-Tissue Papers - As illustrated in Table VIII-22, the general methodology was followed; however, because BPT was identified as primary clarification, data relating to mills where biological treatment is employed were excluded from the computations. BPT effluent limitations are attained through the application of primary treatment at mills 090008, 090011, 090013, 090022, 090024, and 090028. Data were reviewed with respect to waste significant grade changes in three specific delineations: none, less than one, and greater than one waste significant change per day. For mills with

TABLE VIII-19
DISCHARGE MONITORING REPORT DATA
WASTEPAPER-MOLDED PRODUCTS SUBCATEGORY(a)

Mill Number	Final Effluent Long-Term Average Levels: Flow kl/kkg (kgal/t)	Final Effluent Long-Term Average Levels: BOD5 kg/kkg (lb/t)	Final Effluent Long-Term Average Levels: TSS kg/kkg (lb/t)	Start Date	Number Of Months Data: Flow	Number Of Months Data: BOD5	Number Of Months Data: TSS
150007(b)	56.7 (13.58)	12.0 (24.05)	13.3 (26.51)	10/79	12	12	12
150011	48.2 (11.55)	3.2 (6.36)	3.5 (6.91)	09/78	28	28	28
150021(b)(c)	1456.2 (348.96)	1.9 (3.87)	4.0 (7.91)	07/77	30	30	30
150025(d)(e)(f)	105.5 (25.29)	0.7 (1.38)	0.7 (1.37)	01/78	12	11	11
BPT-Final Effluent Levels	88.1 (21.1)	1.3 (2.6)	3.2 (6.4)				

(a) NSPS Option 1 final effluent levels are the same as those determined for NSPS Option 2.
(b) This mill has no external treatment system.
(c) Mill is now closed.
(d) Effluent combined with non-contact cooling water.
(e) This mill has primary treatment only.
(f) TSS and BOD5 are less than or equal to BPT.

TABLE VIII-20
DISCHARGE MONITORING REPORT DATA
BUILDERS' PAPER AND ROOFING FELT SUBCATEGORY(a)

Mill Number	Final Effluent Long-Term Average Levels						Start Date	Number Of Months Data		
	Flow		BOD5		TSS					
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)		Flow	BOD5	TSS
120004(c)	2.3	(0.54)	0.2	(0.31)	0.5	(1.01)	07/77	42	39	42
120006(b)(c)	115.8	(27.74)	1.0	(2.09)	0.3	(0.67)	07/77	47	47	40
120008	27.4	(6.56)	1.6	(3.11)	1.7	(3.30)	07/77	31	32	32
120020(b)(c)	13.0	(3.11)	0.1	(0.11)	0.1	(0.21)	07/78	34	34	34
120021(c)	0.2	(0.05)	0.4	(0.77)	0.0	(0.08)	10/79	4	19	19
BPT-Final Effluent Levels	60.1	(14.4)	1.6	(3.2)	1.6	(3.2)				

(a) NSPS Option 1 final effluent levels are the same as those determined for NSPS Option 2.
(b) This mill has primary treatment only.
(c) TSS and BOD5 are less than or equal to BPT.

TABLE VIII-21
DISCHARGE MONITORING REPORT DATA
NONINTEGRATED-FINE PAPERS SUBCATEGORY

Mill Number	Final Effluent Long-Term Average Levels			Start Date	Number Of Months Data		
	Flow	BOD5	TSS		Flow	BOD5	TSS
	kl/kkg (kgal/t)	kg/kkg (lb/t)	kg/kkg (lb/t)				
Wood Fiber Furnish							
080007(a)	55.5 (13.31)	1.4 (2.88)	1.6 (3.28)	08/77	40	41	40
080009(b)	65.5 (15.69)	3.3 (6.60)	1.7 (3.48)	01/78	36	36	36
080018	30.2 (7.24)	2.8 (5.57)	2.0 (3.94)	09/78	25	25	25
080027(a)(c)	30.6 (7.34)	0.9 (1.82)	0.7 (1.31)	01/78	38	38	38
080030(b)	22.5 (5.39)	--- ---	24.2 (48.48)	07/77	27	0	27
080033(b)	45.4 (10.87)	4.7 (9.40)	2.6 (5.25)	07/77	40	41	41
080040(b)(d)	103.0 (24.69)	13.4 (26.71)	14.6 (29.21)	07/77	9	9	9
080041(a)	113.9 (27.29)	1.7 (3.40)	1.4 (2.72)	11/78	28	28	28
080046(a)	53.2 (12.75)	1.1 (2.21)	1.8 (3.54)	03/79	25	25	25
080048(b)(d)	65.0 (15.57)	11.0 (22.09)	1.1 (2.15)	04/79	24	24	24
080049(b)	46.4 (11.11)	4.1 (8.17)	5.3 (10.60)	08/78	31	31	31
080051	53.5 (12.82)	2.7 (5.42)	2.5 (5.04)	10/79	16	16	16
105047(a)(b)	49.4 (11.84)	1.8 (3.51)	1.1 (2.18)	07/77	39	45	45
900059(b)	40.4 (9.69)	3.0 (6.04)	1.6 (3.20)	11/77	40	40	40
BPT-Final Effluent Levels	63.0 (15.2)	2.4 (4.8)	3.3 (6.5)				
Average of Mills Attaining BPT BOD5 and TSS		1.4 (2.83)	1.6 (3.18)				
Cotton Fiber Furnish							
080003(a)	169.4 (40.59)	3.7 (7.33)	2.7 (5.44)	07/77	46	46	46
080032(e)	68.7 (16.46)	2.0 (3.98)	0.8 (1.65)	01/79	28	27	28
080042(d)	67.6 (16.15)	10.7 (21.35)	29.3 (58.61)	07/78	18	18	18
080044	155.4 (37.25)	6.9 (13.77)	2.2 (4.49)	11/79	13	14	14
BPT-Final Effluent Levels	176.5 (42.3)	5.1 (10.2)	7.2 (14.3)				

(a) TSS and BOD5 are less than or equal to BPT.
(b) Data are not included in the average because this mill employs primary treatment only.
(c) Data are not included in the average because the mill employs chemically assisted clarification.
(d) This mill now discharges to a POTW.
(e) This mill discharges a variable amount of raw wastewater to a POTW.

TABLE VIII-22
DISCHARGE MONITORING REPORT DATA
NONINTEGRATED - TISSUE PAPERS SUBCATEGORY

Mill Number	Final Effluent Long-Term Average Levels: Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)	Start Date	Number Of Months Data: Flow	BOD5	TSS
040006	91.9 (22.03)	4.9 (9.70)	2.6 (5.28)	08/79	21	22	22
090001(a)(b)	70.8 (16.96)	1.6 (3.12)	1.0 (1.97)	07/77	24	42	42
090005(a)(b)(c)	11.4 (2.73)	0.2 (0.42)	0.2 (0.45)	09/77	29	29	29
090007(a)(b)	92.7 (22.21)	0.2 (0.47)	0.6 (1.28)	07/77	36	36	36
090008(a)	57.3 (13.74)	2.2 (4.44)	0.7 (1.31)	07/77	47	47	47
090011(a)(c)	53.1 (12.72)	2.4 (4.88)	1.2 (2.30)	07/77	28	28	27
090013(a)	29.5 (7.06)	1.1 (2.28)	0.6 (1.24)	08/77	40	40	40
090019	80.4 (19.26)	2.9 (5.82)	3.3 (6.54)	07/77	46	46	46
090022(a)	62.1 (14.87)	3.0 (6.09)	2.7 (5.46)	07/77	20	28	26
090024(a)	81.8 (19.61)	1.0 (1.90)	0.7 (1.41)	07/77	22	22	22
090028(a)(c)	91.8 (22.00)	2.2 (4.34)	1.9 (3.82)	01/78	36	36	36
090031	97.9 (23.47)	2.0 (4.01)	3.2 (6.41)	07/77	36	36	36
090032	133.9 (32.08)	2.4 (4.76)	3.4 (6.88)	08/77	26	44	44
555555	73.3 (17.57)	4.9 (9.79)	7.6 (15.19)	04/79	21	21	21
BPT-Final Effluent Levels	96.0 (22.9)	3.5 (7.0)	2.9 (5.7)				
Average of All Mills Attaining BPT BOD5 and TSS		1.6 (3.10)	1.1 (2.14)				
Average of Mills Attaining BPT BOD5 and TSS							
-No waste significant grade changes per day		1.6 (3.17)	0.68 (1.36)				
-Less than one waste significant grade change per day		2.7 (5.49)	1.9 (3.88)				

(a) TSS and BOD5 are less than or equal to BPT.
(b) Data not included in the average because the mill employs biological treatment.
(c) Mill is now closed.

data available on grade change, EPA found that a significant difference in long-term average discharge levels due to grade change existed. Therefore, the NSPS Option 1 effluent loads are based on the highest long-term average loads, which occurred at those mills with less than one grade change per day (mills 090011 and 090022).

Nonintegrated-Lightweight Papers - For both product sectors in this new subcategory, EPA determined NSPS Option 1 effluent loads based on the transfer of performance from the best performing mills in the nonintegrated-tissue papers subcategory. EPA applied the average percentage reductions beyond BPT for the nonintegrated-tissue papers subcategory (21.6 percent for BOD_5 and 31.9 percent for TSS) to the final BPT limitations for this subcategory. As explained previously, EPA determined that the characteristics and treatability of wastewaters discharged from mills in the nonintegrated-lightweight papers subcategory and the nonintegrated-tissue papers subcategory are similar. Therefore, the Agency believes that new mills in the nonintegrated-lightweight papers subcategory will be able to attain the NSPS Option 1 long-term average discharge characteristics. Available effluent data for mills in this subcategory are presented in Table VIII-23.

Nonintegrated-Filter and Nonwoven Papers - For this new subcategory, EPA determined NSPS Option 1 effluent loads based on the transfer of performance from the best performing mills in the nonintegrated-tissue papers subcategory. EPA applied the average percentage reductions beyond BPT for the nonintegrated-tissue papers subcategory (21.6 percent for BOD_5 and 31.9 percent for TSS) to the final BPT limitations for this subcategory. As explained previously, EPA determined that the characteristics and treatability of wastewaters discharged from mills in the nonintegrated-filter and nonwoven papers subcategory and the nonintegrated-tissue papers subcategory are similar. Therefore, the Agency believes that new mills in the nonintegrated-filter and nonwoven papers subcategory will be able to attain the NSPS Option 1 long-term average discharge characteristics. Available effluent data for mills in this subcategory are presented in Table VIII-24.

Nonintegrated-Paperboard - For this new subcategory, EPA determined NSPS Option 1 effluent loads based on the transfer of performance from the best performing mills in the nonintegrated-tissue papers subcategory. EPA applied the average percentage reductions beyond BPT for the nonintegrated-tissue papers subcategory (21.6 percent for BOD_5 and 31.9 percent for TSS) to the final BPT limitations for this subcategory. As explained previously, EPA determined that the characteristics and treatability of wastewaters discharged from mills in the nonintegrated-paperboard subcategory and the nonintegrated-tissue papers subcategory are similar. Therefore, the Agency believes that new mills in the nonintegrated-paperboard subcategory will be able to attain the NSPS Option 1 long-term average discharge characteristics. Available effluent data for mills in this subcategory are presented in Table VIII-25.

TABLE VIII-23
DISCHARGE MONITORING REPORT DATA
NONINTEGRATED - LIGHTWEIGHT PAPERS SUBCATEGORY[1]

Mill Number	Final Effluent Long-Term Average Levels			Start Date	Number Of Months Data		
	Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)		Flow	BOD5	TSS
Lightweight							
080021(a)(d)	66.0 (15.81)	0.9 (1.74)	0.5 (1.08)	07/77	34	34	34
080022(d)	82.0 (19.65)	1.3 (2.63)	2.1 (4.15)	01/78	31	31	29
080024(d)	45.2 (10.82)	0.6 (1.27)	0.7 (1.48)	01/78	23	23	23
090003(b)(d)	63.4 (15.20)	3.1 (6.15)	2.0 (3.90)	08/77	41	43	43
090015(a)(d)	117.6 (28.18)	2.3 (4.51)	2.1 (4.26)	11/78	30	30	30
105013(a)	319.9 (76.65)	7.2 (14.49)	8.9 (17.72)	07/77	34	36	36
105020(d)	189.9 (45.51)	1.3 (2.65)	1.8 (3.59)	01/78	37	37	37
BPT-Final Effluent Levels	203.2 (48.7)	7.4 (14.7)	6.0 (12.0)				
Electrical							
105003(c)(d)	417.3(100.00)	4.6 (9.17)	3.4 (6.78)	01/78	23	23	23
105018(a)(d)	678.1(162.49)	3.7 (7.41)	3.1 (6.17)	07/77	41	44	44
BPT-Final Effluent Levels	320.9 (76.9)	11.6 (23.2)	9.5 (19.0)				

(a) This mill has biological treatment.
(b) This mill has no external treatment.
(c) Mill is now closed.
(d) TSS and BOD5 are less than or equal to BPT.

[1] Option 1 levels are based on transfer of technology from Nonintegrated-Tissue Papers Subcategory.

TABLE VIII-24
DISCHARGE MONITORING REPORT DATA
NONINTEGRATED - FILTER AND NONWOVEN PAPERS SUBCATEGORY[1]

	Final Effluent Long-Term Average Levels					
Mill	Flow	BOD5	TSS	Start	Number Of Months Data		
Number	kl/kkg (kgal/t)	kg/kkg (lb/t)	kg/kkg (lb/t)	Date	Flow	BOD5	TSS
105033(a)(b)	170.5 (40.86)	1.8 (3.56)	1.1 (2.18)	07/77	43	44	44
105034(a)(b)	204.3 (48.95)	3.8 (7.51)	2.8 (5.63)	07/77	39	44	44
105051(b)	168.1 (40.28)	1.4 (2.85)	2.2 (4.33)	07/77	12	12	12
105055(a)(b)	249.9 (59.88)	1.5 (2.99)	2.9 (5.77)	12/77	33	33	33
BPT-Final Effluent Levels	250.0 (59.9)	9.1 (18.1)	7.4 (14.8)				

(a) This mill has biological treatment.
(b) TSS and BOD5 are less than or equal to BPT.

[1] Option 1 levels are based on transfer of technology from Nonintegrated-Tissue Papers subcategory.

TABLE VIII-25
DISCHARGE MONITORING REPORT DATA
NONINTEGRATED - PAPERBOARD SUBCATEGORY[1]

Mill Number	Final Effluent Long-Term Average Levels Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)	Start Date	Number Of Months Data Flow	BOD5	TSS
085001(a)(d)	19.8 (4.75)	0.7 (1.43)	0.4 (0.72)	07/77	44	45	44
085007	167.9 (40.24)	1.5 (3.09)	2.2 (4.45)	07/77	46	43	40
105002	238.0 (57.04)	4.8 (9.66)	2.2 (4.30)	07/77	30	28	28
105048(b)(d)	26.1 (6.26)	0.3 (0.59)	0.2 (0.49)	01/78	33	32	33
105049(b)(c)	51.3 (12.30)	5.5 (10.99)	0.5 (1.04)	03/78	11	11	11
110021(a)	57.2 (13.70)	1.5 (3.03)	2.7 (5.34)	07/77	41	40	40
BPT-Final Effluent Levels	53.8 (12.9)	2.0 (3.9)	1.6 (3.2)				

(a) This mill has biological treatment.
(b) This mill has no external treatment.
(c) This mill now discharges to a POTW.
(d) TSS and BOD5 are less than or equal to BPT.

[1] Option 1 levels are based on transfer of technology from Nonintegrated-Tissue Papers subcategory.

The NSPS Option 1 long-term average final effluent loads developed as described above are presented in Table VIII-26.

Attainment of NSPS Option 1. Table VIII-27 summarizes the number of mills attaining BPT and NSPS Option 1 long-term average final effluent loads along with the number of direct discharging mills in each subcategory for which data were available. At 44 percent of the mills in the integrated segment, 62 percent of the mills in the secondary fibers segment, and 76 percent of the mills in the nonintegrated segment where BPT effluent limitations are attained, NSPS Option 1 limits are also attained.

EPA compared the NSPS Option 1 final effluent loads presented in Table VIII-26, the NSPS Option 1 raw waste loads shown in Table VIII-3, and the raw waste and final effluent loads that form the basis of BPT effluent limitations. The Agency found that, for all subcategories, compliance with NSPS Option 1 final effluent loads would require a higher BOD5 percent reduction than required by compliance with BPT effluent limitations. Therefore, the end-of-pipe systems that form the basis of NSPS Option 1 must be more efficient in removing BOD5 than the systems that form the basis of BPT effluent limitations.

To determine if these higher percent reductions are demonstrated in this industry, for all mills used in developing NSPS Option 1 long-term average final effluent loads, EPA compared BOD5 effluent loads to BOD5 raw waste loads. Raw waste and final effluent data presented in Sections V and VIII, respectively, were used; in some cases, more recent raw waste load data were available and were used in the analysis. The percent reductions in BOD5 being attained at actual mills were then compared to those that form the basis of NSPS Option 1, which are presented in Table VIII-28. In completing this assessment, EPA investigated eight major industry sectors: bleached kraft, unbleached kraft/semi-chemical, sulfite, groundwood, deink, other secondary fibers, nonintegrated-fine papers, and other nonintegrated. As shown in Table VIII-29 and as discussed below, mills in every major sector achieve the percent reductions of BOD5 that form the basis of NSPS Option 1. Because waste characteristics and waste treatability are similar between the subcategories in each sector, EPA has determined that mills representative of all subcategories in each sector are capable of achieving equivalent reductions.

In the bleached kraft sector, BOD5 reductions that form the basis of NSPS Option 1 range from 91 to 94 percent. BOD5 percent reductions within this range are being attained at mills 030010, 030030, 030032, 030046, and 032002. BOD5 reductions of greater than 94 percent are being attained at mills 030020, 030027, and 777777.

In the unbleached kraft and semi-chemical sector, BOD5 reductions that form the basis of NSPS Option 1 range from 92 to 95 percent. BOD5 percent reductions within this range are being attained at mills 010008, 015004, and 060004 and at mills 010020 and 010025 where

TABLE VIII-26

NSPS OPTION 1
LONG-TERM AVERAGE
DISCHARGE CHARACTERISTICS

	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Integrated Segment						
Dissolving Kraft	230.0	(55.1)	4.8	(9.64)	8.2	(16.33)
Market Bleached Kraft	173.0	(41.6)	3.3	(6.62)	5.7	(11.44)
BCT Bleached Kraft	148.0	(35.4)	2.6	(5.16)	4.3	(8.64)
Alkaline-Fine[1]	129.0	(30.9)	1.9	(3.87)	3.0	(6.05)
Unbleached Kraft						
o Linerboard	52.5	(12.6)	1.3	(2.57)	2.2	(4.37)
o Bag	52.5	(12.6)	1.5	(3.00)	2.7	(5.44)
Semi-Chemical	42.9	(10.3)	1.2	(2.36)	2.2	(4.40)
Unbleached Kraft and Semi-Chemical	58.4	(14.0)	1.4	(2.70)	2.4	(4.70)
Dissolving Sulfite Pulp						
o Nitration	275.0	(66.0)	8.5	(16.96)	12.5	(25.08)
o Viscose	275.0	(66.0)	9.1	(18.15)	12.5	(25.08)
o Cellophane	275.0	(66.0)	9.9	(19.70)	12.5	(25.08)
o Acetate	303.4	(72.7)	12.4	(24.88)	12.5	(25.08)
Papergrade Sulfite[2]	*	*	*	*	*	*
Groundwood-Thermo-Mechanical	88.0	(21.1)	1.6	(3.18)	2.7	(5.45)
Groundwood-CMN Papers	99.0	(23.8)	1.5	(2.98)	2.2	(4.41)
Groundwood-Fine Papers	91.0	(21.9)	1.4	(2.74)	2.0	(4.01)
Secondary Fibers Segment						
Deink						
o Fine Papers	102.0	(24.4)	2.5	(4.93)	3.7	(7.31)
o Tissue Papers	102.0	(24.4)	3.3	(6.64)	4.5	(9.04)
o Newsprint	67.6	(16.2)	1.7	(3.43)	3.3	(6.57)
Tissue From Wastepaper	68.0	(16.3)	1.3	(2.56)	2.8	(5.66)
Paperboard From Wastepaper						
o Corrugating Medium Furnish	13.4	(3.2)	1.1	(2.25)	1.2	(2.41)
o Noncorrugating Medium Furnish	13.4	(3.2)	0.73	(1.46)	0.97	(1.93)
Wastepaper-Molded Products	23.8	(5.7)	0.60	(1.19)	1.2	(2.30)
Builders' Paper and Roofing Felt	11.3	(2.7)	0.49	(0.98)	0.73	(1.45)
Nonintegrated Segment						
Nonintegrated-Fine Papers						
o Wood Fiber Furnish	63.0	(15.2)	1.4	(2.83)	1.6	(3.18)
o Cotton Fiber Furnish	176.5	(42.3)	3.0	(6.01)	3.5	(7.00)
Nonintegrated-Tissue Papers	96.0	(22.9)	2.7	(5.49)	1.9	(3.88)
Nonintegrated-Lightweight Papers						
o Lightweight	203.7	(48.7)	5.8	(11.56)	4.1	(8.16)
o Electrical	320.9	(76.9)	9.1	(18.26)	6.4	(12.88)
Nonintegrated-Filter and Nonwoven Papers	250.0	(59.9)	7.1	(14.22)	5.0	(10.03)
Nonintegrated-Paperboard	53.8	(12.9)	1.5	(3.06)	1.1	(2.16)

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

*NSPS vary with the percent sulfite pulp in the final product. These equations can be used to obtain annual average effluent characteristics for Papergrade Sulfite mills:

Flow (kl/kkg) $= 52.87 \exp(0.017x)$
BOD5 (kg/kkg) $= 1.72 \exp(0.017x)$
TSS (kg/kkg) $= 2.22 \exp(0.017x)$

where x equals the percent sulfite pulp produced on-site in the final product.

TABLE VIII-27

NUMBER OF FACILITIES THAT ATTAIN BPT AND NSPS OPTION 1 FINAL EFFLUENT CHARACTERISTICS

	Mills with Available Data	Mills Attaining BPT F.E. Levels(a)	Mills Attaining NSPS Option 1 F.E. Levels(a)
Integrated Segment			
Dissolving Kraft	3	2	1
Market Bleached Kraft	9	7	1
BCT Bleached Kraft	7	3	1
Alkaline-Fine[1]	14	5	3
Unbleached Kraft			
o Linerboard	16	9	4
o Bag	10	3	2
Semi-Chemical	15	4	2
Unbleached Kraft and Semi-Chemical	9	3	1
Dissolving Sulfite Pulp			
o Nitration	0	0	0
o Viscose	2	0	0
o Cellophane	1	0	0
o Acetate	2	0	0
Papergrade Sulfite[2]	11	5	2
Groundwood-Thermo-Mechanical	2	1	1
Groundwood-CMN Papers	2	1	1
Groundwood-Fine Papers	6	5	2
Secondary Fibers Segment			
Deink			
o Fine Papers	3	3	0
o Tissue Papers	10	6	3
o Newsprint	1	1	1
Tissue From Wastepaper	9	7	2
Paperboard From Wastepaper			
o Corrugating Medium Furnish	3	2	1
o Noncorrugating Medium Furnish	37	21	18
Wastepaper-Molded Products	4	1	0
Builders' Paper and Roofing Felt	5	4	3
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	12	5	2
o Cotton Fiber Furnish	2	1	0
Nonintegrated-Tissue Papers	14	9	6
Nonintegrated-Lightweight Papers			
o Lightweight	7	6	6
o Electrical	2	2	2
Nonintegrated-Filter and Nonwoven Papers	4	4	4
Nonintegrated-Paperboard	5	2	2

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

(a) F.E. = Final Effluent

TABLE VIII-28

PERCENT REDUCTIONS
REQUIRED TO ATTAIN NSPS OPTION 1 BOD_5
FINAL EFFLUENT CHARACTERISTICS
FROM NSPS OPTION 1 BOD_5 RAW WASTE LOADS

Integrated Segment	Percent Reduction*
Dissolving Kraft	93
Market Bleached Kraft	91
BCT Bleached Kraft	93
Alkaline-Fine[1]	94
Unbleached Kraft	
o Linerboard	92
o Bag	94
Semi-Chemical	95
Unbleached Kraft and Semi-Chemical	93
Dissolving Sulfite Pulp	
o Nitration	94
o Viscose	94
o Cellophane	95
o Acetate	95
Papergrade Sulfite[2]	95
Groundwood-Thermo-Mechanical	93
Groundwood-CMN Papers	91
Groundwood-Fine Papers	92
Secondary Fibers Segment	
Deink	
o Fine Papers	97
o Tissue Papers	96
o Newsprint	89
Tissue From Wastepaper	87
Paperboard From Wastepaper	
o Corrugating Medium Furnish	95
o Noncorrugating Medium Furnish	94
Wastepaper-Molded Products	89
Builders' Paper and Roofing Felt	92
Nonintegrated Segment	
Nonintegrated-Fine Papers	
o Wood Fiber Furnish	87
o Cotton Fiber Furnish	87
Nonintegrated-Tissue Papers	76
Nonintegrated-Lightweight Papers	
o Lightweight	73
o Electrical	58
Nonintegrated-Filter and Nonwoven Papers	41
Nonintegrated-Paperboard	85

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

*Percent reduction
= [raw waste load (lb/t) - final effluent (lb/t)] x 100/raw waste load (lb/t)
except for Papergrade Sulfite subcategories for which percent reduction is defined in terms of concentrations (mg/l).

TABLE VIII-29

PERCENT BOD5 REDUCTIONS ATTAINED AT SOME MILLS MEETING BPT BOD5 AND TSS FINAL EFFLUENT LEVELS

Sector/Mill Number	Percent Reductions to attain NSPS Option 1 BOD5 F.E. Levels(a)	Raw Waste Load BOD5(b) (lb/t)	Final Effluent BOD5(b) (lb/t)	Percent Reduction From Raw Waste BOD5 to Final Effluent BOD5
Bleached Kraft	91-94			
030010		74.3	4.9	93
030020		51.0	2.7	95
030027		46.9(1)	1.3	97
030030		88.1	5.4	94
030032		66.1(1)	5.1	92
030046		62.3	4.1	93
032002		78.7	7.5	91
777777		71.8(2)	3.1	96
Unbleached Kraft and Semi-Chemical	92-95			
010008		37.6	2.0	95
010020(c)		41.0	2.2	95
010025(c)		27.8	1.1	96
015004		34.2	1.7	95
020003		50.5	0.7	99
060004		37.4(1)	2.5	93
Sulfite	94-95			
040009(d)		163.0(3)	2.95(3)	98
040016(e)		218.5	13.07	94
040017(e)		194.2	10.57	95
040019		93.1(4)	3.92(4)	96
Groundwood	91-93			
052003		24.3	1.6	93
052007		38.8(5)	1.9	95
052008		20.1	0.9	96
052014		24.0	0.6	98
054014		33.6	2.5	93
054015		42.7	2.5	94
070001		38.0	3.2	92
Deink	89-97			
140007		110.0	4.4	96
140008		145.5	6.5	96
140014		130.4(6)	8.8	93
140015		72.2(5)	6.8	91
140019		41.8	4.0	90
140021		160.5	4.4	97
Other Secondary Fiber	87-95			
085004		44.7	3.6	92
100005		28.4	3.7	87
110001		25.0	0.3	99
110025		38.6	1.7	96
110031		7.1(5)	0.3	96
110043		23.5(5)	1.6	93
110052		18.1	0.8	96
110057		35.0	1.7	95
110062		22.9	1.1	95
110069		14.8	0.5	97
110110		22.4	0.4	98
120004		10.9	0.3	97
Nonintegrated-Fine Papers	87			
080041		29.8	3.4	89
080046		27.6	2.2	92

TABLE VIII-29 (cont.)

Other Nonintegrated	41-85			
090008		30.6	4.4	86
090013		12.6	2.3	82
090022		18.2	6.1	66
105020		16.5	2.7	84
105051		9.9	2.9	71

(a) These represent the range of the percent reductions required to attain the subcategory NSPS Option 1 final effluent BOD_5 levels from NSPS Option 1 raw waste loads.

Percent reduction = [raw waste BOD_5 (lb/t) - final effluent BOD_5 (lb/t)] x 100/raw waste BOD_5 (lb/t)

except for the Papergrade Sulfite subcategories for which the percent reduction is defined in terms of concentrations (mg/l).

(b) The sources of the raw waste load data and the final effluent data are the 308 Survey and long-term average BOD_5 levels from the Discharge Monitoring Reports respectively except as noted below:

(1) Data are from the Supplemental Data Request Program.
(2) One year raw waste data obtained from mill representatives.
(3) The raw waste BOD_5 load is the total load from mills 040009 and 030051, which share a joint treatment system. Final effluent data are from the joint treatment system.
(4) The percent reduction is based on influent to and effluent from the biological treatment system. Data are from the Supplemental Data Request Program.
(5) Data are from the Verification Data Request Program.
(6) The percent reduction is based on raw waste BOD_5 to biological treatment and total final effluent from both biological and primary treatment.

(c) The treatment system used at this mill is a storage oxidation basin.

(d) This mill shares a joint treatment system with a fine bleached kraft mill. Approximately 40 percent of the combined output of the two mills is sulfite pulp. Prorated BPT was calculated for the combined mills and it was determined that the treatment system attained BPT levels.

(e) This mill attains the BOD_5 comparison level but not the TSS comparison level.

oxidation ponds are employed. A BOD5 reduction of greater than 95 percent is being attained at mill 020003.

In the sulfite sector, BOD5 reductions that form the basis of NSPS Option 1 range from 94 to 95 percent. A 96 percent BOD5 reduction is now attained at mill 040019. (At mill 040019, only pulp mill wastes are biologically treated.) [The BPT long-term average BOD5 effluent load is now attained at mills 040016 and 040017; however, the BPT long-term average TSS effluent load is exceeded. At mills 040016 and 040017, BOD5 percent reductions of between 94 and 95 percent are attained. Also, mill 040009, a papergrade sulfite mill, shares a joint treatment system with a bleached kraft mill. About 60 percent of the BOD5 raw waste load is associated with the papergrade sulfite operations. At mill 040009, a BOD5 reduction of over 98 percent is attained.]

In the groundwood sector, the BOD5 reductions that form the basis of NSPS Option 1 range from 91 to 93 percent. BOD5 percent reductions within this range are being attained at mills 052003, 054014, and 070001. BOD5 reductions of greater than 93 percent are being attained at mills 052007, 052008, 052014, and 054015.

In the deink sector, BOD5 reductions that form the basis of NSPS Option 1 range from 89 to 97 percent. BOD5 percent reductions within this range are being attained at mills 140007, 140008, 140014, 140015, and 140019. A BOD5 percent reduction of 97 percent is being attained at mill 140021.

In the other secondary fibers sector, BOD5 reductions that form the basis of NSPS Option 1 range from 87 to 95 percent. BOD5 percent reductions within this range are being attained at mills 085004, 100005, 110043, 110057, and 110062. BOD5 reductions of greater than 95 percent are being attained at mills 110001, 110025, 110031, 110052, 110069, 110110, and 120004.

In the nonintegrated-fine papers sector, the BOD5 reduction that forms the basis of NSPS Option 1 is 87 percent. BOD5 percent reductions equal to or in excess of 87 percent are being attained at mills 080041 and 080046.

In the other nonintegrated sector, the BOD5 reductions that form the basis of NSPS Option 1 range from 41 to 85 percent. BOD5 reductions within this range are being attained at mills 090013, 090022, 105020, and 105051. A BOD5 percent reduction of greater than 85 percent is being attained at mill 090008.

As shown above, end-of-pipe biological treatment is capable of attaining the percent reductions in BOD5 that form the basis of NSPS Option 1 in all subcategory sectors where biological treatment is the technology basis of BPT effluent limitations. Both the activated sludge process and aerated stabilization basins are capable of attaining these reductions. In northern climates, available data show that the activated sludge process is superior in its ability to control pulp, paper, and paperboard industry discharges.(203) In the nonintegrated subcategories where primary treatment forms the basis of BPT effluent limitations, end-of-pipe primary treatment is capable of attaining the percent reductions in BOD5 that form the basis of NSPS Option 1.

Some commenters on the January 1981 proposed regulations expressed concern that few existing mills in the integrated segment were attaining the proposed NSPS. These commenters stated that EPA had overstated the capability of biological treatment to reduce BOD5 raw waste loads in this segment. As discussed above, biological treatment systems now employed in the integrated segment are capable of reducing BOD5 to the extent required by NSPS Option 1. Because the conventional activated sludge system that forms the basis of NSPS Option 1 must achieve a higher BOD5 percent reduction than required by compliance with BPT effluent limitations, the Agency conducted further investigations to ensure that the system that forms the basis of NSPS Option 1 has been properly sized to ensure that the higher BOD5 reductions would be attained at all mills.

In the development document supporting proposed rules, EPA published the design criteria for end-of-pipe biological treatment systems that the Agency believed to be capable of attaining the effluent concentrations required to attain proposed NSPS. These design criteria, which are identical to NSPS Option 1 design criteria, are presented in Table VIII-30. (This table also presents the design criteria for aerated stabilization basins and extended aeration activated sludge systems that EPA believes are equivalent to the conventional activated sludge systems that form the basis of NSPS Option 1. See Section IX of the development document supporting proposed rules. (203)). As shown, these systems are considerably larger than those that form the basis of BPT effluent limitations.

Table VIII-31 compares EPA's design criteria to the actual design criteria for treatment systems employed at mills where the percent reductions of BOD5 that are necessary to attain NSPS Option 1 are achieved. As shown, conventional activated sludge systems (and the equivalent aerated stabilization basins and extended aeration activated sludge systems) that form the basis of NSPS Option 1 are larger than the systems generally employed at actual mills where the percent reductions required to achieve NSPS Option 1 limits are attained. Therefore, the larger end-of-pipe treatment systems that form the basis of NSPS Option 1 for the integrated segment, at a minimum, are capable of attaining the percent reductions in BOD5 that are required by NSPS Option 1.

In summary, the percent reductions in BOD5 that form the basis of NSPS Option 1 are being attained at mills in each subcategory or at mills in related subcategories where wastewaters have similar characteristics and treatability. These reductions are being attained through the use of treatment systems that are even smaller than those that form the basis of NSPS Option 1. Mill personnel in many subcategories of the pulp, paper, and paperboard industry have not

TABLE VIII-30

A COMPARISON OF
NSPS OPTION I DESIGN CRITERIA
TO BPT DESIGN CRITERIA

	BPT	NSPS
Activated Sludge		
Primary clarification (cu m/d/sq m)	24	20
Equalization (hours)	12	12
Aeration Basin		
o Detention Time (hours)	8	12
o Organic Loading (kg BOD5/d/cu m)	0.8	0.5
Aeration (kg BOD5/d/HP)	19	11.2
Secondary clarification (cu m/d/sq m)	20	16
Extended Aeration		
Primary clarification (cu m/d/sq m)	24	20
Equalization (hours)	12	12
Aeration Basin		
o Detention Time (hours)	30	48
o Organic Loading (kg BOD5/d/cu m)	0.3-0.6	0.2
Aeration (kg BOD5/d/HP)	19	11.2
Secondary Clarification (cu m/d/sq m)	20	16
Aerated Stabilization Basin		
Primary Clarification (cu m/d/sq m)	24	20
Aeration Basin		
o Detention Time (days)	13	13
o Organic Loading (kg BOD5/d/1000 cu m)	18.4	18.4
Aeration		
o Organic (kg BOD5/d/HP)	15.3	15.3
o Mixing (HP/1000 cu m)	(a)	2.6
Settling (days)	1	10

(a) Aerator mixing was not considered in BPT design criteria.

TABLE VIII-31

A COMPARISON OF NSPS OPTION I DESIGN CRITERIA TO CRITERIA USED AT INTEGRATED MILLS WHERE BOD5 REDUCTIONS COMPARABLE TO THOSE REQUIRED TO ATTAIN NSPS OPTION I ARE ACHIEVED

	NSPS Design Criteria	Actual Mill			
Activated Sludge		Average	Median	Minimum	Maximum
Primary clarification (cu m/d/sq m)	20	20	20	10	28
Aeration Basin					
o Detention Time (hours)	12.0	7.8	6.9	2.9	16.4
o Organic Loading (kg BOD5/d/cu m)	0.5	0.9	0.9	0.6	1.2
Aeration (kg BOD5/HP)	11.2	17.0	14.9	11.1	29.4
Secondary clarification (cu m/d/sq m)	16	18	17	15	23
Extended Aeration					
Primary clarification (cu m/d/sq m)	20	35	28	12	63
Aeration Basin					
o Detention Time (hours)	48	45.2	29.4	19.0	117.6
o Organic Loading (kg BOD5/d/cu m)	0.2	0.3	0.2	0.1	1.1
Aeration (kg BOD5/HP)	11.2	17.5	13.9	7.3	32.8
Secondary clarification (cu m/d/sq m)	16	25	24	6	43
Aerated Stabilization Basin					
Primary clarification (cu m/d/sq m)	20	19	20	8	25
Aeration Basin					
o Detention Time (days)	13	9.7	9.7	0.9	15.2
o Organic Loading (kg BOD5/d/cu m)	18.4	30.5	22.1	13.2	94.9
Aeration					
o Organic Loading (kg BOD5/HP)	15.3	16.7	16.2	11.9	24.0
o Mixing (HP/1000 cu m)	2.6	2.0	1.3	0.6	6.6
Settling (days)	10	9.9	9.9	0.2	22.2

chosen to use these larger systems, but the technology is readily available for application at new mills. Because (a) larger systems can be readily designed, constructed, and operated at new sources in every subcategory and (b) the wastewater and operating characteristics of new mills are similar to those mills where the NSPS Option 1 reductions are now achieved, EPA has determined that all new mills in every subcategory will be capable of attaining NSPS Option 1 limitations based on the use of expanded end-of-pipe treatment systems.

Option 2

BPT for the pulp, paper, and paperboard industry was generally based on the implementation of commonly-employed production process controls and end-of-pipe treatment. Biological treatment was the end-of-pipe treatment for all of the original subcategories with the exception of the nonintegrated-tissue papers subcategory for which BPT was based on primary treatment. The technology basis for control of conventional pollutants for NSPS Option 2 is implementation of additional commonly-employed production process controls and end-of-pipe treatment technologies.

By reviewing the previously published production process control items that formed the basis of BPT and BAT effluent limitations (see Phase I and Phase II Development Documents (46) (48)) and the data request program responses from 644 mills, EPA identified additional commonly employed production process controls that can further reduce raw waste loads. These controls serve as the basis for defining a NSPS technology option (NSPS Option 2) in which raw waste loads are lower than those that form the basis of BPT effluent limitations. The controls that are generally applicable to each subcategory and which form the basis of EPA's estimates of the cost of attainment of NSPS Option 2 raw waste loads are presented in Tables VIII-32 through VIII-34. NSPS Option 2 also includes the application of end-of-pipe treatment systems that are identical in design to those that form the basis of NSPS Option 1 for each subcategory.

The methodology used to develop raw waste loads and anticipated final effluent characteristics are discussed below.

Development of Raw Waste Loads. NSPS Option 2 raw waste flows and BOD_5 loads are generally based on the average discharge flow and BOD_5 raw waste loads at mills where discharges are lower than those that form the basis of BPT effluent limitations. The NSPS Option 2 raw waste TSS has been assumed to be the same as that which forms the basis of BPT because (a) the TSS raw waste loads have little, if any effect on final effluent BOD_5 and TSS loads (as discussed previously, the TSS final effluent concentration is a function of the BOD_5 raw waste concentration) and (b) to ensure that EPA's cost estimates do not understate the cost of solid waste disposal associated with primary clarification. Because the Option 2 raw waste loads generally were derived from actual mill data, in the majority of cases it was not necessary to predict what reductions would be attained through

TABLE VIII-32

PRODUCTION PROCESS CONTROLS FORMING THE BASIS OF COST ESTIMATES FOR NSPS OPTION 2
INTEGRATED SEGMENT

Control	Subcategory											
	Dissolving Kraft	Market Bleached Kraft	BCT Bleached Kraft	Alkaline-Fine[1]	Unbleached Kraft	Semi-Chemical	Unbleached Kraft and Semi-Chemical	Dissolving Sulfite Pulp	Papergrade Sulfite[2]	Groundwood-TMP	Groundwood-CMN Papers	Groundwood-Fine Papers
1. Woodyard/Woodroom												
a. Close-up or dry woodyard and barking operation	-	-	-	X	X	X	X	X	X	X	-	X
b. Segregate cooling water	X	-	-	-	-	-	-	X	-	X	-	-
2. Pulp Mill												
a. Reuse blow condensates	X	X	X	X	X	X	-	-	X	-	-	-
b. Reduce groundwood thickener overflow	-	-	-	-	-	-	-	-	-	-	-	X
c. Spill Collection	X	X	X	X	-	X	X	X	X	X	X	X
3. Washers and Screen Room												
a. Add 3rd or 4th stage washer or press	X	X	X	X	X	X	X	X	X	-	-	-
b. Decker filtrate reuse	-	-	-	-	X	X	X	X	-	-	X	-
4. Bleaching												
a. Countercurrent washing	-	X	X	X	-	-	-	X	X	-	-	-
b. Evaporate caustic extraction stage filtrate	-	-	-	-	-	-	-	X	-	-	-	-
5. Evaporation and Recovery Areas												
a. Replace barometric condenser	X	-	-	-	-	-	-	-	-	-	-	-
b. Add boil out tank	X	X	X	X	X	-	X	-	-	-	-	-
c. Neutralize spent sulfite liquor	-	-	-	-	-	-	-	X	X	-	-	-
d. Segregate cooling water	-	X	-	-	X	X	X	-	-	-	-	-
e. Spill Collection	X	-	X	X	-	X	X	-	X	-	-	-
f. Reuse evaporator condensate	-	-	-	-	X	X	X	-	-	-	-	-
6. Liquor Preparation Area												
a. Spill Collection	X	X	X	X	-	-	X	X(a)	X(a)	-	-	-
7. Paper Mill												
a. Spill Collection:												
1. Paper machine and bleached pulp	X	-	X	-	-	X	-	X	X	X	X	X
2. Color plant	-	-	-	-	-	-	-	-	X	-	-	X

TABLE VIII-32 (Continued)

Control	Dissolving Kraft	Market Bleached Kraft	BCT Bleached Kraft	Alkaline-Fine[1]	Un-bleached Kraft	Semi-Chemical	Unbleached Kraft and Semi-Chemical	Dissolving Sulfite Pulp	Papergrade Sulfite[2]	Groundwood-TMP	Groundwood-CMN Papers	Groundwood-Fine Papers
7. Paper Mill (continued)												
b. Improve saveall	-	-	-	-	-	-	-	-	-	-	-	-
c. High pressure showers for wire and felt cleaning	X	-	-	-	-	-	-	X	X	X	X	X
d. White water use for vacuum pump sealing	X	-	X	-	-	-	-	X	X	-	X	X
e. Paper machine white water showers for wire cleaning	-	-	-	-	-	-	X	-	-	-	-	-
f. White water storage for upsets and pulper dilution	-	-	-	-	-	-	X	-	-	X	X	X
g. Recycle press water	X	-	-	-	-	-	-	X	X	-	X	X
h. Reuse vacuum pump water	-	-	-	-	-	-	-	X	X	-	X	X
i. Broke storage	-	-	-	-	X	X	X	-	-	-	X	-
j. Wet lap machine	-	-	-	-	-	-	-	-	-	X	X	X
k. Segregate cooling water	-	-	-	-	X	X	X	-	X	-	X	X
l. Cleaner rejects to landfill	-	-	-	-	-	-	-	-	-	-	-	-
m. White water to pulp mill	-	-	-	-	-	-	-	X	-	-	-	-
n. Gland water reduction	-	-	-	-	-	-	-	-	-	-	-	-
8. Steam Plant and Utility Areas												
a. Segregate cooling water	X	X	X	X	X	X	X	X	X	-	-	X
b. Lagoon for boiler blowdown and backwash waters	X	X	X	X	-	-	-	-	X	-	-	-
9. Miscellaneous Controls												
a. Cooling Tower	-	-	-	-	-	-	-	-	-	-	-	-
b. pH monitor	-	X	-	X	-	X	-	-	-	-	-	-
c. Level alarms	-	-	-	-	X	X	X	-	-	X	-	-
d. Filters	-	-	-	-	-	-	-	-	-	-	-	-
e. Recycle of effluent	-	-	-	-	-	-	-	-	-	-	-	-

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

(a) Costs were included with pulp mill collection costs.

TABLE VIII-33

PRODUCTION PROCESS CONTROLS FORMING THE BASIS OF
COST ESTIMATES FOR NSPS OPTION 2
SECONDARY FIBERS SEGMENT

Control	Subcategory				
	Deink	Tissue From Wastepaper	Paperboard From Wastepaper	Wastepaper-Molded Products	Builders' Paper and Roofing Felt
1. Woodyard/Woodroom					
a. Close-up or dry woodyard and barking operation	-	-	-	-	-
b. Segregate cooling water	-	-	-	-	-
2. Pulp Mill					
a. Reuse blow condensates	-	-	-	-	-
b. Reduce groundwood thickener overflow	-	-	-	-	-
c. Spill Collection	X	-	-	-	-
3. Washers and Screen Room					
a. Add 3rd or 4th stage washer or press	-	-	-	-	-
b. Decker filtrate reuse	X	-	-	-	-
4. Bleaching					
a. Countercurrent washing	(1)	-	-	-	-
b. Evaporate caustic extraction stage filtrate	-	-	-	-	-
5. Evaporation and Recovery Areas					
a. Replace barometric condenser	-	-	-	-	-
b. Add boil out tank	-	-	-	-	-
c. Neutralize spent sulfite liquor	-	-	-	-	-
d. Segregate cooling water	-	-	-	-	-
e. Spill collection	-	-	-	-	-
f. Reuse evaporator condensate	-	-	-	-	-
6. Liquor Preparation Area					
a. Spill collection	-	-	-	-	-
7. Paper Mill					
a. Spill collection:					
1. Paper machine and bleached pulp	X	-	-	-	-
2. Color plant	-	-	-	-	-
b. Improve saveall	-	-	X	-	X
c. High pressure showers for wire and felt cleaning	X	-	X	-	-
d. White water use for vacuum pump sealing	X	-	-	-	-
e. Paper machine white water showers for wire cleaning	-	-	-	-	X
f. White water storage for upsets and pulper dilution	-	-	X	-	-
g. Recycle press water	X	X	X	-	-
h. Reuse of vacuum pump water	X	X	X	-	-
i. Broke Storage	-	-	-	-	-
j. Wet lap machine	X	-	-	-	-
k. Segregate cooling water	-	-	-	-	-
l. Cleaner rejects to landfill	-	X	X	-	-
m. White water to pulp mill	-	-	-	-	-
n. Gland water reduction	-	-	X	-	-

TABLE VIII-33 (Continued)

Control	Subcategory Deink	 Tissue From Wastepaper	 Paperboard From Wastepaper	 Wastepaper-Molded Products	 Builders' Paper and Roofing Felt
8. Steam Plant and Utility Areas					
a. Segregate cooling water	X	-	-	-	-
b. Lagoon for boiler blowdown and backwash waters	X	-	-	X	-
9. Miscellaneous Controls					
a. Cooling tower	-	X	X	-	X
b. pH monitor	-	-	-	-	-
c. Level alarms	-	-	X	-	-
d. Filters	-	X	X	-	X
e. Recycle of effluent	-	X	X	X	-

(1) Countercurrent washing was included only for the Tissue product sector of the Deink subcategory.

TABLE VIII-34

PRODUCTION PROCESS CONTROLS FORMING THE BASIS OF COST ESTIMATES FOR NSPS OPTION 2 NONINTEGRATED SEGMENT

	Subcategory				
Control	Nonintegrated-Fine Papers	Nonintegrated-Tissue Papers	Nonintegrated-Lightweight Papers	Nonintegrated-Filter and Nonwoven Papers	Nonintegrated-Paperboard
1. Woodyard/Woodroom					
a. Close-up or dry woodyard and barking operation	-	-	-	-	-
b. Segregate cooling water	-	-	-	-	-
2. Pulp Mill					
a. Reuse blow condensates	-	-	-	-	-
b. Reduce groundwood thickener overflow	-	-	-	-	-
c. Spill collection	-	-	-	-	-
3. Washers and Screen Room					
a. Add 3rd or 4th stage washer or press	-	-	-	-	-
b. Decker filtrate reuse	-	-	-	-	-
4. Bleaching					
a. Countercurrent washing	-	-	-	-	-
b. Evaporate caustic extraction stage filtrate	-	-	-	-	-
5. Evaporation and Recovery Areas					
a. Replace barometric condenser	-	-	-	-	-
b. Add boil out tank	-	-	-	-	-
c. Neutralize spent sulfite liquor	-	-	-	-	-
d. Segregate cooling water	-	-	-	-	-
e. Spill collection	-	-	-	-	-
f. Reuse evaporator condensate	-	-	-	-	-
6. Liquor Preparation Area					
a. Spill collection	-	-	-	-	-
7. Paper Mill					
a. Spill collection:					
1. Paper machine and bleached pulp	X	X	X	X	-
2. Color plant	X	-	-	-	-
b. Improve saveall	-	-	X	X	-
c. High pressure showers for wire and felt cleaning	X	X	X	X	-
d. White water use for vacuum pump sealing	X	-	X	X	X
e. Paper machine white water showers for wire cleaning	-	-	X	X	X
f. White water storage for upsets and pulper dilution	-	-	X	X	-
g. Recycle press water	X	X	X	-	X
h. Reuse of vacuum pump water	X	-	X	-	X
i. Broke Storage	-	-	X	X	-
j. Wet lap machine	-	-	-	-	-
k. Segregate cooling water	X	X	X	-	-
l. Cleaner rejects to landfill	-	-	-	-	-
m. White water to pulp mill	-	-	-	-	-
n. Gland water reduction	-	-	-	-	-
8. Steam Plant and Utility Areas					
a. Segregate cooling water	X	X	-	X	X
b. Lagoon for boiler blowdown and backwash waters	X	X	X	X	-
9. Miscellaneous Controls					
a. Cooling tower	-	-	-	-	X
b. pH monitor	-	-	-	-	-
c. Level alarms	-	X	-	-	-
d. Filters	-	-	-	-	-
e. Recycle of effluent	-	-	X	X	X

application of each of the production process controls available to the mills within a specific subcategory. However, in several instances where only limited data were available, EPA found it necessary to predict the raw waste load reductions attainable through the application of specific production process controls identified as NSPS Option 2 technologies.

The controls that serve as the basis of reductions of raw waste loads beyond those considered in developing BPT effluent limitations are presented in Tables VIII-35 through VIII-37. The controls are those that can be employed at mills in each subcategory to achieve the NSPS Option 2 raw waste loads developed from actual mill data (presented in Section V) for each subcategory.

Dissolving Kraft - The dissolving kraft subcategory is comprised of three mills. Raw waste load data for these mills and the raw waste loads that formed the basis of BPT are presented in Table V-1. Very few mills are included in this subcategory and varying percentages of dissolving pulp are produced at these mills; therefore, the general methodology was not used as there was insufficient raw waste load data available corresponding to the production of 100 percent dissolving kraft pulp. EPA determined NSPS Option 2 raw waste loads by subtracting predicted waste load reductions from the raw waste loads that formed the basis of BPT. Estimates were made of the raw waste load reductions attainable through the implementation of specific production process controls applicable to this subcategory. As summarized, the subcategory average raw waste loads are: flow - 198.2 kl/kkg (47.5 kgal/t), BOD_5 - 69.6 kg/kkg (139.1 lb/t), and TSS - 111.3 kg/kkg (222.6 lb/t). The raw waste loads for BPT are: flow - 230.0 kl/kkg (55.1 kgal/t), BOD_5 - 66.5 kg/kkg (133.0 lb/t), and TSS - 113.0 kg/kkg (226.0 lb/t).

The production process controls that have been identified as applicable in this subcategory and that form the basis for EPA's estimates of attainable raw waste load reductions are: improved brownstock washing, improved utilization of digester blow condensates, brownstock and bleached pulp spill collection, additional liquor storage, and improved white water use. The total projected flow and BOD_5 reductions are 18.4 kl/kkg (4.4 kgal/t) and 8.2 kg/kkg (16.3 lb/t), respectively. Because each of these production process controls has been employed at dissolving kraft mills and/or at bleached kraft mills representative of other subcategories, EPA believes that these technologies can be applied at new source mills in this subcategory. Based on engineering calculations supported by the literature or material balances, the Agency believes that the application of these production process controls can achieve the required degree of effluent reduction.

TABLE VIII-35

PRODUCTION PROCESS CONTROLS IN ADDITION TO THOSE THAT FORM THE BASIS OF
BPT THAT CAN BE EMPLOYED TO
ACHIEVE NSPS OPTION 2 RAW WASTE LOADS
INTEGRATED SEGMENT

	Subcategory											
Control	Dissolving Kraft	Market Bleached Kraft	BCT Bleached Kraft	Alkaline-Fine¹	Un-bleached Kraft	Semi-Chemical	Unbleached Kraft and Semi-Chemical	Dissolving Sulfite Pulp	Papergrade Sulfite²	Ground-wood-TMP	Ground-wood-CMN Papers	Ground-wood-Fine Papers
1. Woodyard/Woodroom												
a. Close-up or dry woodyard and barking operation	-	-	-	-	-	-	-	X	-	-	-	X
b. Segregate cooling water	X	X	X	X	X	X	X	X	-	X	X	X
2. Pulp Mill												
a. Reuse blow condensates	X	X	X	X	X	-	-	-	-	-	-	-
b. Reduce groundwood thickener overflow	-	-	-	-	-	-	-	-	-	-	-	X
c. Spill collection	X	X	X	X	-	-	-	X	X	-	X	X
3. Washers and Screen Room												
a. Add 3rd or 4th stage washer or press	X	X	X	X	X	X	X	-	X	-	-	-
b. Decker filtrate reuse	-	-	-	-	X	X	X	X	-	-	X	-
4. Bleaching												
a. Countercurrent washing	-	-	-	X	-	-	-	-	X	-	-	-
b. Evaporate caustic extraction stage filtrate	-	-	-	-	-	-	-	X	-	-	-	-
5. Evaporation and Recovery Areas												
a. Replace barometric condenser	X	-	-	-	-	-	-	-	-	-	-	-
b. Add boil out tank	X	X	-	-	-	-	-	-	-	-	-	-
c. Segregate cooling water	-	-	-	-	-	X	-	-	-	-	-	-
d. Spill collection	X	X	X	X	-	-	-	-	-	-	-	-
6. Liquor Preparation Area												
a. Spill collection	X	X	X	X	-	-	-	X	X	-	-	-
7. Paper Mill												
a. Spill collection:												
1. Paper machine and bleached pulp	X	X	X	X	-	-	-	X	X	X	X	X
2. Color plant	-	-	-	X	-	-	-	-	-	-	-	X

TABLE VIII-35 (Continued)

Control	Subcategory											
	Dissolving Kraft	Market Bleached Kraft	BCT Bleached Kraft	Alkaline-Fine[1]	Un-bleached Kraft	Semi-Chemical	Unbleached Kraft and Semi-Chemical	Dissolving Sulfite Pulp	Papergrade Sulfite[2]	Ground-wood-TMP	Ground-wood-CMN Papers	Ground-wood-Fine Papers
7. Paper Mill (continued)												
b. Improve saveall	-	-	-	-	-	-	-	-	-	-	-	-
c. High pressure showers for wire and felt cleaning	X	-	-	-	-	-	-	X	-	-	-	-
d. White water use for vacuum pump sealing	X	-	X	X	-	-	-	X	X	-	X	X
e. Paper machine white water showers for wire cleaning	-	-	-	-	-	-	-	-	-	-	-	-
f. White water storage for upsets and pulper dilution	-	-	-	-	-	-	-	X	-	-	X	-
g. Recycle press water	X	-	-	-	X	X	X	-	X	-	X	X
h. Reuse of vacuum pump water	-	-	-	X	X	X	X	X	X	-	X	X
i. Broke storage	-	-	-	-	-	-	-	-	-	-	-	-
j. Wet lap machine	-	-	-	X	-	-	-	-	X	X	X	X
k. Segregate cooling water	-	-	-	-	-	-	-	-	-	-	-	-
l. Cleaner rejects to landfill	-	-	-	-	-	-	-	-	-	-	-	-
m. White water to pulp mill	-	-	-	-	-	-	-	X	-	-	-	-
n. Gland water reduction	-	-	-	-	-	-	-	-	-	-	-	-
8. Steam Plant and Utility Areas												
a. Segregate cooling water	X	-	-	-	-	-	-	X	-	-	-	X
b. Lagoon for boiler blowdown and backwash waters	X	X	X	X	-	-	-	-	X	-	-	-
9. Miscellaneous Controls												
a. High level alarms	-	-	-	-	-	-	-	-	-	-	-	-
b. Cooling tower	-	-	-	-	-	-	-	-	-	-	-	-
c. Recycle of effluent	-	-	-	-	-	-	-	-	-	-	-	-

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE VIII-26

PRODUCTION PROCESS CONTROLS IN ADDITION TO THOSE THAT FORM THE BASIS OF BPT THAT CAN BE EMPLOYED TO ACHIEVE NSPS OPTION 2 RAW WASTE LOADS SECONDARY FIBERS SEGMENT

	Subcategory				
Control	Deink	Tissue From Wastepaper	Paperboard From Wastepaper	Wastepaper-Molded Products	Builders' Paper and Roofing Felt
1. Woodyard/Woodroom					
a. Close-up or dry woodyard and barking operation	-	-	-	-	-
b. Segregate cooling water	-	-	-	-	-
2. Pulp Mill					
a. Reuse blow condensates	-	-	-	-	-
b. Reduce groundwood thickener overflow	-	-	-	-	-
c. Spill collection	X	-	-	-	-
3. Washers and Screen Room					
a. Add 3rd or 4th stage washer or press	-	-	-	-	-
b. Decker filtrate reuse	-	-	-	-	-
4. Bleaching					
a. Countercurrent washing	-	-	-	-	-
b. Evaporate caustic extraction stage filtrate	-	-	-	-	-
5. Evaporation and Recovery Areas					
a. Replace barometric condenser	-	-	-	-	-
b. Add boil out tank	-	-	-	-	-
c. Segregate cooling water	-	-	-	-	-
d. Spill collection	-	-	-	-	-
6. Liquor Preparation Area					
a. Spill collection	-	-	-	-	-
7. Paper Mill					
a. Spill collection:					
1. Paper machine and bleached pulp	-	-	-	-	-
2. Color plant	-	-	-	-	-
b. Improve saveall	-	-	B	-	X
c. High pressure showers for wire and felt cleaning	X	-	B	-	-
d. White water use for vacuum pump sealing	X	-	-	-	-
e. Paper machine white water showers for wire cleaning	-	-	-	-	X
f. White water storage for upsets and pulper dilution	-	-	X	-	-
g. Recycle press water	-	-	B	-	-
h. Reuse of vacuum pump water	-	-	B	-	-
i. Broke storage	-	-	-	-	-
j. Wet lap machine	X	-	-	-	-
k. Segregate cooling water	-	-	-	-	-
l. Cleaner rejects to landfill	-	X	B	-	-
m. White water to pulp mill	-	-	-	-	-
n. Gland water reduction	-	-	B	-	-
8. Steam Plant and Utility Areas					
a. Segregate cooling water	X	-	-	-	-
b. Lagoon for boiler blowdown and backwash waters	X	-	-	X	-
9. Miscellaneous Controls					
a. High level alarms	-	X	X	-	-
b. Cooling tower	-	-	-	-	-
c. Recycle of effluent	-	X	X	X	X

B-These production process controls were erroneously included as BPT production process controls. They were included in EPA's determination of NSPS Option 2 raw waste loads.

TABLE VIII-37

PRODUCTION PROCESS CONTROLS IN ADDITION TO THOSE THAT FORM THE BASIS OF BPT THAT CAN BE EMPLOYED TO ACHIEVE NSPS OPTION 2 RAW WASTE LOADS NONINTEGRATED SEGMENT

	Subcategory				
Control	Nonintegrated-Fine Papers	Nonintegrated-Tissue Papers	Nonintegrated-Lightweight Papers	Nonintegrated-Filter and Nonwoven Papers	Nonintegrated-Paperboard
1. Woodyard/Woodroom					
a. Close-up or dry woodyard and barking operation	-	-	-	-	-
b. Segregate cooling water	-	-	-	-	-
2. Pulp Mill					
a. Reuse blow condensates	-	-	-	-	-
b. Reduce groundwood thickener overflow	-	-	-	-	-
c. Spill collection	-	-	-	-	-
3. Washers and Screen Room					
a. Add 3rd or 4th stage washer or press	-	-	-	-	-
b. Decker filtrate reuse	-	-	-	-	-
4. Bleaching					
a. Countercurrent washing	-	-	-	-	-
b. Evaporate caustic extraction stage filtrate	-	-	-	-	-
5. Evaporation and Recovery Areas					
a. Replace barometric condenser	-	-	-	-	-
b. Add boil out tank	-	-	-	-	-
c. Segregate cooling water	-	-	-	-	-
d. Spill collection	-	-	-	-	-
6. Liquor Preparation Area					
a. Spill collection	-	-	-	-	-
7. Paper Mill					
a. Spill collection:					
1. Paper machine and bleached pulp	X	X	-	X	-
2. Color plant	X	-	-	-	-
b. Improve saveall	-	-	X	X	-
c. High pressure showers for wire and felt cleaning	X	-	X	X	-
d. White water use for vacuum pump sealing	X	-	X	-	X
e. Paper machine white water showers for wire cleaning	-	-	-	X	X
f. White water storage for upsets and pulper dilution	-	-	X	-	-
g. Recycle press water	-	-	-	-	X
h. Reuse of vacuum pump water	X	-	-	-	X
i. Broke storage	-	-	X	-	-
j. Wet lap machine	-	-	-	-	-
k. Segregate cooling water	X	X	X	-	-
l. Cleaner rejects to landfill	-	-	-	-	-
m. White water to pulp mill	-	-	-	-	-
n. Gland water reduction	-	-	-	-	-
8. Steam Plant and Utility Areas					
a. Segregate cooling water	-	-	-	X	X
b. Lagoon for boiler blowdown and backwash waters	X	X	X	-	-
9. Miscellaneous Controls					
a. High level alarms	-	X	-	-	-
b. Cooling tower	-	-	-	-	X
c. Recycle of effluent	-	-	X	X	X

The resulting NSPS Option 2 flow and BOD5 raw waste loads are presented below:

Dissolving Kraft - Development of Option 2 Raw Waste Loads

	Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)
BPT RWL	230.0 (55.1)	66.5 (133.0)
Reductions Resulting from Application of Specific Production Process Controls	18.4 (4.4)	8.2 (16.3)
Option 2 RWL	211.6 (50.7)	58.4 (116.7)

The TSS raw waste load for Option 2 has been assumed to be the same as that used as the basis for BPT, or 113.0 kg/kkg (226.0 lb/t) of product.

Market Bleached Kraft - Data presented in Table V-2 for the production of both bleached hardwood kraft (HWK) and bleached softwood kraft (SWK) pulp are arranged in order of increasing softwood pulp production. Of the mills where raw waste loads are lower than or equal to those used to develop BPT, raw waste load BOD5 is essentially the same at both hardwood and softwood mills. However, when considering flow data, mills where bleached softwood pulp is produced have a higher average flow. The average flow for softwood and hardwood mills where flows are less than that which formed the basis of BPT are 152.7 kl/kkg (36.6 kgal/t) and 120.6 kl/kkg (28.9 kgal/t), respectively. The proposed Option 2 flow has been chosen as the higher of the two, 152.7 kl/kkg (36.6 kgal/t). This approach gives an adequate allowance for all types of market kraft mills: hardwood, softwood, and mixtures of both. The average BOD5 raw waste load for softwood and hardwood mills where BOD5 raw waste loads are less than the BPT basis are 29.3 kg/kkg (58.6 lb/t) and 26.6 kg/kkg (53.2 lb/t), respectively. Since the data for both types of wood pulps are substantially the same, the higher BOD5 raw waste load, 29.3 kg/kkg (58.6 lb/t), has been assumed. The TSS raw waste load for Option 2 has been assumed to be the same as that used as the basis of BPT. In summary, the Option 2 raw waste loads for the market bleached kraft subcategory are: flow - 152.7 kl/kkg (36.6 kgal/t), BOD5 - 29.3 kg/kkg (58.6 lb/t), and TSS - 45.0 kg/kkg (90.0 lb/t).

BCT (Paperboard, Coarse, and Tissue) Bleached Kraft - Raw waste load data for bleached kraft mills where paperboard, coarse papers, and tissue papers are manufactured are presented in Table V-3. Of the eight mills for which data are presented, five are achieving flows and three are achieving BOD5 raw waste loads that are less than those which formed the basis of BPT. For one of the mills (030039) attaining a lower flow and BOD5 raw waste load, data correspond to biological treatment plant influent rather than to a true raw waste. These data were not used in any calculations of attainable NSPS Option 2 raw waste loads. Option 2 raw waste loads for this subcategory are based on the averages of those mills where raw waste loads that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 2 flow and BOD5 raw waste loads of 132.3 kl/kkg (31.7 kgal/t) and 35.1 kg/kkg (70.2 lb/t), respectively. The TSS raw waste load for Option 2 has been assumed to be the same as that used as the basis of BPT, or 66.5 kg/kkg (133.0 lb/t) of product.

Alkaline-Fine (Fine Bleached Kraft and Soda Subcategories) - Data are presented in Table V-4 for 20 mills characteristic of the fine bleached kraft subcategory. There are 15 mills in this subcategory where flow and/or BOD5 raw waste loads are lower than those which formed the basis of BPT. Option 2 raw waste loads for this subcategory are based on the averages of those mills where raw waste loads that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 2 flow and BOD5 raw waste loads of 104.7 kl/kkg (25.1 kgal/t) and 27.1 kg/kkg (54.1 lb/t), respectively. The TSS raw waste load for Option 2 has been assumed to be the same as that used as the basis of BPT, or 75.0 kg/kkg (150.0 lb/t) of product.

Unbleached Kraft - Data are presented in Table V-5 for mills characteristic of this subcategory. In the development of BPT effluent limitations guidelines, the unbleached kraft subcategory included mills manufacturing unbleached kraft linerboard, bag, and/or other mixed products. Data provided in response to the data request program suggest that there are differences in waste characteristics for mills manufacturing linerboard and bag or other mixed products. The following summarizes the subcategory averages for the two product sectors.

Unbleached Kraft-Raw Waste Load Summary

	Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)	TSS kg/kkg (lb/t)
Unbleached Kraft - Linerboard:	47.6 (11.4)	16.6 (33.2)	15.8 (31.6)
Unbleached Kraft - Bag and Other Products:	103.5 (24.8)	24.3 (48.6)	31.4 (62.8)

In establishing NSPS Option 2 raw waste loads, EPA evaluated data for both the linerboard and bag product sectors. NSPS Option 2 raw waste loads for the linerboard product sector are based on the averages of those mills where raw waste loadings that are lower than those which formed the basis of BPT are attained. For the bag and other products product sector, NSPS Option 2 raw waste loads are based on the averages of those mills where (a) raw waste flow is lower than that which formed the basis of BPT and (b) raw waste BOD5 is lower than the product sector average raw waste load. Application of this methodology yields unbleached kraft-linerboard Option 2 raw waste loads for flow and BOD5 of 39.2 kl/kkg (9.4 kgal/t) and 12.4 kg/kkg (24.8 lb/t), respectively, and unbleached kraft-bag and other products raw waste loads for flow and BOD5 of 47.6 kl/kkg (11.4 kgal/t) and 16.9 kg/kkg (33.8 lb/t), respectively. The TSS Option 2 raw waste loads for both product sectors have been assumed to be the same as that used as the basis of BPT, or 21.9 kg/kkg (43.8 lb/t) of product.

Semi-Chemical - Available raw waste load data for semi-chemical mills are presented in Table V-6. The data are presented according to wastepaper use and use of liquor recovery. Variable amounts of wastepaper are utilized at mills in this subcategory according to relative market conditions and pricing. Because of this variation, two mill groups were considered in the development of NSPS Option 2 raw waste loads. The groups are: (a) mills with liquor recovery where less than one-third of the furnish is wastepaper and (b) mills with liquor recovery where more than one-third of the furnish is wastepaper. Review of the data in Table V-6 indicates significant differences in flow between the two groups [35.9 kl/kkg (8.6 kgal/t) versus 18.8 kl/kkg (4.5 kgal/t)], but no significant difference in BOD5 [22.1 kg/kkg (44.1 lb/t) versus 23.9 kg/kkg (47.8 lb/t)]. Therefore, the Option 2 raw waste load for flow is based on an average of those mills with liquor recovery where less than one-third wastepaper is processed and a raw waste load lower than that which formed the basis of BPT is attained. The Option 2 raw waste load for BOD5 is based on data from both groups of mills where a BOD5 raw waste load lower than that which formed the basis of BPT is attained. Application of this methodology yields NSPS Option 2 raw waste loads of flow and BOD5 of 30.5 kl/kkg (7.3 kgal/t), and 17.6 kg/kkg (35.2 lb/t), respectively. The TSS raw waste load for Option 2 has been assumed to be the same as that which formed the basis of BPT, or 12.3 kg/kkg (24.6 lb/t) of product.

Unbleached Kraft and Semi-Chemical - Table V-7 presents available raw waste load data for this subcategory. NSPS Option 2 raw waste loads for this subcategory are based on averages of those mills where raw waste loads that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 2 raw waste loads for flow and BOD5 of 48.0 kl/kkg (11.5 kgal/t) and 16.3 kg/kkg (32.5 lb/t), resepctively. The TSS raw waste load for Option 2 has been assumed to be the same as that which formed the basis of BPT, or 20.5 kg/kkg (41.0 lb/t) of product.

Dissolving Sulfite Pulp - Table V-8 presents available raw waste load data for this subcategory. In previous effluent limitations guidelines development, EPA recognized that a variety of products are made at dissolving sulfite pulp mills that result in different waste characteristics.(48) However, in the data request program, only limited data were provided for this subcategory on raw waste load by product types. Consequently, EPA estimated the raw waste load reductions attainable through the application of specific production process controls.

Several specific production process control modifications are applicable in this subcategory and are shown in Table VIII-35. Each of these controls has been employed at dissolving sulfite pulp mills and, therefore, can be applied at new source mills in this subcategory. In general, most of the items under consideration result in minor flow reductions with the exception of recycle of the hydraulic barking water. Flow reductions resulting from cooling water segregation, more extensive use of white water in the pulp and paper mills, and additional spill collection can reduce wastewater discharge by 29.2 kl/kkg (7.0 kgal/t). Additional applicable production process controls include implementation of liquor spill and pulp dryer spill collection systems and improved recycle of decker filtrate. Predicted $BOD\underline{5}$ reductions resulting from the application of these controls in addition to white water reuse total 5.0 kg/kkg (10.0 lb/t). Another applicable control, caustic filtrate evaporation, results in $BOD\underline{5}$ reductions varying from 41.4 kg/kkg (82.8 lb/t) for the nitration grade to 104.4 kg/kkg (208.8 lb/t) for the acetate grade. This technology is an expensive production process control, yet one that can result in significant $BOD\underline{5}$ reduction. This technology has been employed at mills 046002 and 046006.

The resulting NSPS Option 2 $BOD\underline{5}$ raw waste loads are presented below. Based on engineering calculations supported by the literature or material balances, EPA believes that the application of the specific production process controls identified above can achieve the required degree of effluent reduction. This is further supported by available data. The controls on which NSPS Option 2 are based are installed at mill 046006. As illustrated in Table V-8, when acetate grade pulp is produced at mill 046006, the NSPS Option 2 flow and $BOD\underline{5}$ raw waste loads are attained.

Dissolving Sulfite-Development of Option 2 BOD5 Raw Waste Load

	BOD5 - kg/kkg (lb/t)			
	Nitration	Viscose	Cellophane	Acetate
BPT - RWL	137 (274)	156 (312)	181.5 (363)	266.0 (531.9)[1]
Reductions Resulting from Application of Specific Production Process Controls	46.4 (92.8)	63.4 (126.8)	71.9 (143.8)	109.4 (218.8)
Option 2 BOD5 RWL	90.6 (181.2)	92.6 (185.2)	109.6 (219.2)	156.6 (313.1)

[1] [As discussed in Section II, the BPT BOD5 limitation for acetate grade production in the dissolving sulfite pulp subcategory was remanded by the Court of Appeals. The Agency has not yet promulgated the BOD5 limitation. Therefore, a BOD5 raw waste load corresponding to BPT effluent limitations has not yet been established. The BOD5 raw waste load of 266.0 kg/kkg (531.9 lb/t) is representative of the BOD5 raw waste load associated with the production of acetate grade dissolving sulfite pulp at the time the remanded BPT BOD5 limitation was promulgated in 1977.]

The flow basis of BPT is 275.0 kl/kkg (66.0 kgal/t) except for mills where acetate grade pulp is produced where the flow basis of BPT has been assumed to be 303.4 kl/kkg (72.7 kgal/t). (The flow value of 303.4 kl/kkg (72.7 kgal/t) is representative of the wastewater flow rate associated with the production of acetate grade dissolving sulfite pulp at the time the remanded BPT BOD5 limitation was promulgated in 1977.) Flow reduction through implementation of production process controls is 29.2 kl/kkg (7.0 kgal/t). This results in an Option 2 flow of 246.2 kl/kkg (59.0 kgal/t) for the nitration, viscose, and cellophane pulp grades and 274.2 kl/kkg (65.7 kgal/t) for the acetate pulp grade. The TSS raw waste load for Option 2 has been assumed to be the same as that which formed the basis of BPT, or 92.5 kg/kkg (185.0 lb/t) of product.

Papergrade Sulfite (Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) Subcategories) - Table V-9 presents available raw waste load data for this subcategory. In the development of BPT effluent limitations, two papergrade sulfite subcategories were established: blow pit wash and drum wash. However, as discussed previously in Sections IV and V, the percentage of sulfite pulp produced on-site is a better indication of raw waste load characteristics than the type of pulp washing system employed. The NSPS Option 2 flow is based on flow data for those mills where discharge flow is lower than that defined by the regression equation presented previously. The percentage reductions in flow below that defined by the regression equation, taking into account the percentage of sulfite pulp produced on-site, were averaged and form the basis of the NSPS Option 2 flow. At four mills, discharge flow is less than the predicted flow, with the average percent reduction being 28 percent. Therefore, NSPS Option 2 flow is defined as 72 percent of the flow defined by the regression analysis.

EPA based the NSPS Option 2 BOD5 raw waste load on the average of those papergrade sulfite mills where the BOD5 raw waste load is lower than that which formed the basis of BPT, or 66.1 kg/kkg (132.2 lb/t). As discussed in Section V, there is no definable relationship between BOD5 raw waste load and the percentage of sulfite pulp produced on-site. Because the average quantity of sulfite pulp produced on-site is 58 percent of the raw material furnish, EPA assumed that this BOD5 raw waste load is representative of a mill where 58 percent of the raw material furnish is sulfite pulp produced on-site. Therefore, for a model mill where 58 percent of the raw material furnish is sulfite pulp produced on-site, Option 2 flow and BOD5 raw waste loads would be 101.8 kl/kkg (24.4 kgal/t) and 66.1 kg/kkg (132.2 lb/t), respectively. The TSS raw waste load for Option 2 was assumed to be the same as that which formed the basis of BPT, or 90.0 kg/kkg (180.0 lb/t) of product. The BOD5 and TSS concentrations for this model mill form the basis of BOD5 and TSS raw waste concentrations for NSPS Option 2, regardless of the percentage of sulfite pulp produced on-site.

Groundwood-Thermo-Mechanical - Table V-10 presents available raw waste load data for this subcategory. As explained in Section V, the flow and BOD5 raw waste loads that formed the basis of BPT effluent limitations are not reflective of raw waste loads characteristic of the groundwood-thermo-mechanical subcategory. Therefore, EPA developed revised BPT raw waste loads for this subcategory. NSPS Option 2 raw waste loads are based on averages of those mils in this subcategory where raw waste loads that are lower than the revised BPT raw waste loads are attained. Application of this methodology yields Option 2 raw waste loads for flow and BOD5 of 57.6 kl/kkg (13.8 kgal/t) and 17.6 kg/kkg (35.2 lb/t), respectively. The TSS raw waste load for Option 2 has been assumed to be the same as that which formed the basis of BPT, or 39.9 kg/kkg (79.8 lb/t) of product.

Groundwood-CMN Papers - Table V-11 presents available raw waste load data for mills in this subcategory. At no mills in this subcategory are BOD5 raw waste loads being attained that are lower than raw waste loads that formed the basis of BPT. Because the existing performance is inadequate and does not achieve the pollution reduction that is possible at mills in this subcategory, the NSPS Option 2 raw waste loads were based on the subtraction of predicted raw waste load reductions resulting from implementation of available production process controls applicable at mills in this subcategory from the raw waste loads that formed the basis of BPT.

The production process controls that have been identified as applicable in this subcategory that form the basis for EPA's estimates of attainable raw waste load reductions are: segregation of cooling water in the woodroom, addition of pulp mill and paper mill spill collection systems, use of white water in vacuum pumps, recycle of press effluent, and addition of centralized storage capacity for white water reuse. The total projected flow and BOD5 reductions are 29.2 kl/kkg (7.0 kgal/t) and 2.9 kg/kkg (5.7 lbs/t), respectively. Because each of these production process controls has been employed at (a) groundwood-CMN mills, (b) groundwood mills representative of other subcategories, or (c) mills in other subcategories where similar pulp or papermaking processes are employed, EPA believes that these technologies can be applied at new source mills in this subcategory. Based on engineering calculations supported by the literature or material balances, the Agency believes that the application of these production process controls can achieve the required degree of effluent reduction. The resulting NSPS Option 2 flow and BOD5 raw waste loads are presented below:

Groundwood-CMN Papers--Development of Option 2 Raw Waste Loads

	Flow kl/kkg (kgal/t)	BOD5 kg/kkg (lb/t)
BPT RWL	99.3 (23.8)	17.4 (34.8)
Reductions Resulting From Implementation of Specific Production Process Controls	29.2 (7.0)	2.9 (5.7)
Option 2 RWL	70.1 (16.8)	14.6 (29.1)

The TSS raw waste load for Option 2 has been assumed to be the same as that which formed the basis of BPT, or 48.5 kg/kkg (97.0 lb/ton) of product.

Groundwood-Fine Papers - Available raw waste load data for this subcategory are presented in Table V-12. NSPS Option 2 raw waste loads for this subcategory are based on averages of those mills where raw waste loads that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 2 raw waste loads for flow and BOD5 of 64.3 kl/kkg (15.4 kgal/t) and 12.5 kg/kkg (24.9 lb/t), respectively. The TSS raw waste load for Option 2 has been assumed to be the same as that which formed the basis of BPT, or 52.5 kg/kkg (105.0 lb/t) of product.

Deink - Available raw waste load data for mills in this subcategory are presented in Table V-14. A delineation has been made between mills producing fine papers, tissue papers, and newsprint.

For mills where fine papers are produced from deinked wastepaper, NSPS Option 2 raw waste loads are based on averages of those mills where raw waste loads that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 2 raw waste loads for flow and BOD5 of 66.4 kl/kkg (15.9 kgal/ton) and 37.3 kg/kkg (74.6 lb/ton), respectively.

For mills where tissue papers are produced from deinked wastepaper, NSPS Option 2 raw waste loads are based on averages of those mills where raw waste loads that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 2 raw waste loads for flow and BOD5 of 81.4 kl/kkg (19.5 kgal/ton) and 61.3 kg/kkg (122.6 lb/ton), respectively.

As explained earlier in this section, for mills where newsprint is produced from deinked wastepaper, NSPS Option 2 is identical to NSPS Option 1. Flow and BOD5 raw waste loads are based on the average raw waste loads of all mills in this product sector. This results in Option 2 flow and BOD5 raw waste loads of 67.6 kl/kkg (16.2 kgal/t) and 15.9 kg/kkg (31.7 lb/t), respectively.

For all three product sectors, the TSS raw waste load for Option 2 has been assumed to be the same as that which formed the basis of BPT, or 202.5 kg/kkg (405 lb/t) of product.

Tissue from Wastepaper - In the tissue from wastepaper subcategory, extensive use of production process controls to reduce wastewater discharge is practiced. As seen in Table V-15, raw waste load data were initially reviewed taking into account the production of industrial and sanitary tissue. It was determined that no significant differences exist between the two product sectors. In addition, self-contained mills have been identified where both types of tissue are produced.

NSPS Option 2 raw waste loads for this subcategory are based on averages of those mills where raw waste loads that are lower than those which formed the basis of BPT are attained. Mills 090006, 100012, 105007, and 100014 are excluded from Option 2 raw waste averages because extensive wastewater recycle is employed and raw waste flows are significantly lower than for other mills. Application of this methodology yields Option 2 raw waste loads for flow and BOD5 of 68.0 kl/kkg (16.3 kgal/t) and 9.7 kg/kkg (19.3 lb/t), respectively. The TSS raw waste load for Option 2 has been assumed to be the same as that which formed the basis of BPT, or 110.5 kg/kkg (221.0 lb/t) of product.

Paperboard from Wastepaper - Available raw waste load data for mills in this subcategory are presented in Table V-16. As discussed previously, EPA determined that BOD5 raw waste loads are substantially higher when recycled corrugating medium is processed than when other types of wastepaper are processed. No such correlation exists between wastewater flow and the type of furnish used. As discussed previously, two subcategory subdivisions have been identified to account for BOD5 raw waste load differences that result from the type of furnish used. NSPS Option 2 flows for each subcategory subdivision are based on the average of those mills where raw waste flows are lower than those which formed the basis of BPT. Application of this methodology yields NSPS Option 2 raw waste flow of 13.4 kl/kkg (3.2 kgal/t). NSPS Option 2 BOD5 raw waste loads for the corrugating medium furnish and noncorrugating medium furnish subdivisions are the same as those which formed the basis of BPT, or 23.0 kg/kkg (46.0 lb/t) and 11.3 kg/kkg (22.5 lb/t), respectively. The TSS raw waste load for Option 2 has been assumed to be the same as that which formed the basis of BPT, or 11.0 kg/kkg (21.9 lb/t) of product.

Wastepaper-Molded Products - Available raw waste load data for mills in this subcategory are presented in Table V-18. This is a new subcategory for which BPT is now being promulgated. A review of data request responses reveals that extensive recycle of effluent is practiced at several mills. NSPS Option 2 raw waste loads are based on averages for those mills where extensive recycle is practiced. Application of this methodology yields Option 2 flow and BOD5 raw waste loads of 23.8 kl/kkg (5.7 kgal/t) and 5.5 kg/kkg (10.9 lb/t), respectively. The TSS raw waste load for Option 2 has been assumed to be the same as that which forms the basis of BPT, or 14.8 kg/kkg (29.6 lb/t) of product.

Builders' Paper and Roofing Felt - Raw waste load data for mills in this subcategory are presented in Table V-19. NSPS Option 2 raw waste loads for this subcategory are based on averages of those mills where raw waste loadings that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 2 raw waste loads for flow and BOD5 of 11.3 kl/kkg (2.7 kgal/t) and 6.5 kg/kkg (13.0 lb/t), respectively. The TSS raw waste load for Option 2 has been assumed to be the same as that which formed the basis of BPT, or 35 kg/kkg (70 lb/t) of product.

Nonintegrated-Fine Papers - Available raw waste load data for mills in this subcategory are presented in Table V-22. As discussed previously in Section IV and V, two subdivisions have been considered: the wood fiber furnish subdivision and the cotton fiber furnish subdivision. Data were reviewed with respect to waste significant grade changes in three specific delineations: none, less than one, and greater than one waste significant grade change per day. A correlation is apparent; flow and BOD5 raw waste loads tend to increase with the frequency of waste significant grade changes. NSPS Option 2 raw waste loads for the nonintegrated-fine papers subcategory are based on the highest averages for the various grade change delineations for mills where raw waste loads that are lower than those that formed the basis of BPT are attained. Application of this methodology for the wood fiber furnish subdivision yields NSPS Option 2 raw waste loads for flow and BOD5 of 39.2 kl/kkg (9.4 kgal/t) and 7.5 kg/kkg (14.9 lb/t), respectively. Application of this methodology for the cotton fiber furnish subdivision yields NSPS Option 2 raw waste loads for flow and BOD5 of 130.2 kl/kkg (31.2 kgal/t) and 14.0 kg/kkg (28.0 kg/kkg). The TSS raw waste load for Option 2 has been assumed to be the same as that which formed the basis of BPT, or 30.8 kg/kkg (61.6 lb/t) of product for the wood fiber furnish subdivision and 55.2 kg/kkg (110.4 lb/t) of product for the cotton fiber furnish subdivision.

Nonintegrated-Tissue Papers - Available raw waste load data for this subcategory are presented in Table V-23. As was done in the nonintegrated-fine papers subcategory, data were reviewed taking into consideration the frequency of waste significant grade changes. In general, wastewater discharge and BOD5 raw waste loads increase with an increase in the frequency of grade changes.

NSPS Option 2 raw waste loads for this subcategory are based on the highest averages for the various grade change delineations for mills where raw waste loads that are lower than those which formed the basis of BPT are attained. Application of this methodology yields Option 2 raw waste loads for flow and BOD5 of 79.7 kg/kkg (19.1 kgal/t) and 9.0 kg/kkg (17.9 lb/t), respectively. The Option 2 flow is based on those mills with greater than one waste significant grade change per day. The Option 2 BOD5 raw waste load is based on those mills with between zero and less than one waste significant grade change per day. The TSS raw waste load for Option 2 has been assumed to be the same as that which forms the basis of BPT, or 34.7 kg/kkg (69.4 lb/t) of product.

Nonintegrated - Lightweight Papers - Available raw waste load data for this subcategory are presented in Table V-24. This is a new subcategory for which BPT is being promulgated. BPT is based on the subcategory average raw waste loads. Two product sectors have been considered - lightweight papers and lightweight electrical papers.

In the development of NSPS Option 2 raw waste loads, data were reviewed with respect to waste significant grade changes. Wastewater discharge and BOD5 raw waste loads increase with the frequency of grade changes. Option 2 raw waste flows for each product sector are based on the highest average for the various grade change delineations for mills where raw waste flows that are lower than those which formed the basis of BPT are attained. Option 2 BOD5 raw waste loads are based on the highest average for the various grade change delineations for mills where raw waste load BOD5 is lower that that which forms the basis of proposed BPT. The Option 2 BOD5 raw waste loads for the lightweight electrical papers product sector is identical to that for the lightweight papers product sector. Application of this methodology yields Option 2 flow and BOD5 raw waste loads (a) for the lightweight papers product sector of 159.4 kl/kkg (38.2 kgal/t) and 13.3 kg/kkg (26.6 lb/t), respectively, and (b) for the lightweight electrical papers product sector of 278.8 kl/kkg (66.8 kgal/t) and 13.3 kg/kkg (26.6 lb/t), respectively. For both product sectors, the TSS raw waste load for Option 2 has been assumed to be the same as that which forms the basis of BPT, or 63.4 kg/kkg (126.8 lb/t) of product.

Nonintegrated-Filter and Nonwoven Papers - Available raw waste load data for mills in this subcategory are presented in Table V-25. This is a new subcategory for which BPT is currently being promulgated. In the development of NSPS Option 2 raw waste loads, data were reviewed with respect to waste significant grade changes. Option 2 raw waste loads are based on the highest averages for the various grade change delineations for mills where raw waste loads are lower than those which form the basis of BPT. Application of this methodology yields Option 2 flow and BOD5 raw waste loads of 198.2 kl/kkg (47.5 kgal/t) and 9.0 kg/kkg (17.9 lb/t), respectively. The proposed TSS raw waste load for Option 2 has been assumed to be the same as that which forms the basis of BPT, or 27.4 kg/kkg (54.7 lb/t).

Nonintegrated-Paperboard - Available raw waste load data for this subcategory are presented in Table V-26. This is a new subcategory for which BPT is currently being promulgated. The subcategory average raw waste loads, exclusive of electrical and matrix board production, form the basis for BPT.

As for the other nonintegrated subcategories, raw waste load data were reviewed with respect to frequency of waste significant grade changes. Option 2 raw waste loads are based on the highest averages for the various grade change delineations for mills with raw waste loads that are lower than those that form the basis for proposed BPT. Application of this methodology yields Option 2 flow and BOD_5 raw waste loads of 46.7 kl/kkg (11.2 kgal/t) and 8.2 kg/kkg (16.4 lb/t), respectively. The TSS raw waste load for Option 2 has been assumed to be the same as that which forms the basis of BPT, or 36.9 kg/kkg (73.7 lb/t) of product.

Summary of Option 2 Raw Waste Loads - Table VIII-38 presents a summary of Option 2 raw waste loads.

Development of Effluent Characteristics. As discussed previously in this section, NSPS Options 1 and 2 are identical for the tissue from wastepaper, wastepaper-molded products, paperboard from wastepaper, and builders' paper and roofing felt subcategories and for the newsprint product sector of the deink subcategory. For the tissue from wastepaper, wastepaper-molded products, paperboard from wastepaper, and builders' paper and roofing felt subcategories, NSPS Options 1 and 2 are based on the application of in-plant production process controls and biological treatment. The biological treatment systems are identical in size to those which form the basis of BPT effluent limitations for these subcategories. For the newsprint product sector of the deink subcategory, the end-of-pipe biological treatment system, is identical in design to that which forms the basis of BPT effluent limitations for the deink subcategory. Because the end-of-pipe treatment systems that form the basis of NSPS Options 1 and 2 for these four subcategories and the subcategory sector are identical to the biological systems that form the basis of BPT effluent limitations for these subcategories, the relationships discussed previously in this section apply.

The NSPS Option 1 and 2 long-term average BOD_5 final effluent concentrations for each of the four subcategories and the subcategory product sector were determined from the equation that relates raw waste BOD_5 concentration to final effluent BOD_5 concentration as presented previously in this section and in the Phase II Development Document (at page 402 (48)):

$$\text{Log } BOD_5 \text{ effluent (mg/l)} = 0.601 \text{ Log } BOD_5 \text{ influent (mg/l)} - 0.020$$

TABLE VIII-38

SUMMARY OF NSPS OPTION 2
RAW WASTE LOADS

	Flow		BOD5		TSS	
	kl/kkg	kgal/t	kg/kkg	lb/t	kg/kkg	lb/t
Integrated Segment						
Dissolving Kraft	211.6	(50.7)	58.4	(116.7)	113.0	(226.0)
Market Bleached Kraft	152.7	(36.6)	29.3	(58.6)	45.0	(90.0)
BCT Bleached Kraft	132.3	(31.7)	35.1	(70.2)	66.5	(133.0)
Alkaline-Fine[1]	104.7	(25.1)	27.1	(54.1)	75.0	(150.0)
Unbleached Kraft						
o Linerboard	39.2	(9.4)	12.4	(24.8)	21.9	(43.8)
o Bag	47.6	(11.4)	16.9	(33.8)	21.9	(43.8)
Semi-Chemical	30.5	(7.3)	17.6	(35.2)	12.3	(24.6)
Unbleached Kraft and Semi-Chemical	48.0	(11.5)	16.3	(32.5)	20.5	(41.0)
Dissolving Sulfite Pulp						
o Nitration	246.2	(59.0)	90.6	(181.2)	92.5	(185.0)
o Viscose	246.2	(59.0)	92.6	(185.2)	92.5	(185.0)
o Cellophane	246.2	(59.0)	109.6	(219.2)	92.5	(185.0)
o Acetate	274.2	(65.7)	156.6	(313.1)	92.5	(185.0)
Papergrade Sulfite[2]	101.8*	(24.4)*	66.1*	(132.2)*	90.0	(180.0)
Groundwood-Thermo-Mechanical	57.6	(13.8)	17.6	(35.2)	39.9	(79.8)
Groundwood-CMN Papers	70.1	(16.8)	14.6	(29.1)	48.5	(97.0)
Groundwood-Fine Papers	64.3	(15.4)	12.5	(24.9)	52.5	(105.0)
Secondary Fibers Segment						
Deink						
o Fine Papers	66.4	(15.9)	37.3	(74.6)	202.5	(405.0)
o Tissue Papers	81.4	(19.5)	61.3	(122.6)	202.5	(405.0)
o Newsprint	67.6	(16.2)	15.9	(31.7)	202.5	(405.0)
Tissue From Wastepaper	68.0	(16.3)	9.7	(19.3)	110.5	(221.0)
Paperboard From Wastepaper						
o Corrugating Medium Furnish	13.4	(3.2)	23.0	(46.0)	11.0	(21.9)
o Noncorrugating Medium Furnish	13.4	(3.2)	11.3	(22.5)	11.0	(21.9)
Wastepaper-Molded Products	23.8	(5.7)	5.5	(10.9)	14.8	(29.6)
Builders' Paper and Roofing Felt	11.3	(2.7)	6.5	(13.0)	35.0	(70.0)
Nonintegrated Segment						
Nonintegrated-Fine Papers						
o Wood Fiber Furnish	39.2	(9.4)	7.5	(14.9)	30.8	(61.6)
o Cotton Fiber Furnish	130.2	(31.2)	14.0	(28.0)	55.2	(110.4)
Nonintegrated-Tissue Papers	79.7	(19.1)	9.0	(17.9)	34.7	(69.4)
Nonintegrated-Lightweight Papers						
o Lightweight	159.4	(38.2)	13.3	(26.6)	63.4	(126.8)
o Electrical	278.8	(66.8)	13.3	(26.6)	63.4	(126.8)
Nonintegrated-Filter and Nonwoven Papers	198.2	(47.5)	9.0	(17.9)	27.4	(54.7)
Nonintegrated-Paperboard	46.7	(11.2)	8.2	(16.4)	36.9	(73.7)

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Fit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

*NSPS flow and BOD5 vary with the percent sulfite pulp in the final product: Flow (kl/kkg) = 38.06 exp(0.017x), where x equals the percent sulfite pulp produced on-site in the final product. Raw waste loads shown are for a mill where on-site papergrade pulp production is 58 percent of the total product.

The long-term average TSS final effluent concentrations were determined from the relationship presented in Figure VIII-1. NSPS Option 1 and 2 long-term average BOD_5 and TSS final effluent loads were calculated as the product of the long-term average final effluent concentrations and the flow basis of NSPS Options 1 and 2.

For the remaining subcategories and subdivisions of subcategories, the end-of-pipe treatment systems that form the basis of NSPS Option 2 are identical in design to those that form the basis of NSPS Option 1 for these subcategories. However, these end-of-pipe systems have longer detention times and increased clarifier capacity than the systems that form the basis of BPT effluent limitations. Therefore, as discussed under NSPS Option 1, they are more effective in removing conventional pollutants. In those subcategories where raw waste BOD_5 concentrations are equal to or lower than NSPS Option 1 raw waste BOD_5 concentrations, these systems are capable of attaining long-term average BOD_5 and TSS final effluent concentrations equal to or lower than NSPS Option 1 long-term average BOD_5 and TSS final effluent concentrations.

As shown in Table VIII-39, NSPS Option 2 BOD_5 raw waste concentrations are equal to or lower than the NSPS Option 1 BOD_5 raw waste concentrations for the dissolving kraft, market bleached kraft, fine bleached kraft, soda, unbleached kraft, semi-chemical, papergrade sulfite, dissolving sulfite pulp, nonintegrated-tissue papers, nonintegrated-filter and nonwoven papers, nonintegrated-lightweight papers, and nonintegrated-paperboard subcategories, the cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory, and the fine and tissue product sectors of the deink subcategory. For these subcategories and subcategory subdivisions, NSPS Option 2 long-term average BOD_5 and TSS final effluent concentrations are equal to NSPS Option 1 long-term average BOD_5 and TSS final effluent concentrations. NSPS Option 2 long-term average BOD_5 and TSS final effluent loads were calculated as the product of the long-term average final effluent concentrations and the flow basis of NSPS Option 2.

As shown in Table VIII-39, NSPS Option 2 raw waste BOD_5 concentrations are greater than NSPS Option 1 raw waste BOD_5 concentrations in the BCT bleached kraft, unbleached kraft and semi-chemical, groundwood-TMP, groundwood-CMN papers, and groundwood-fine papers subcategories and the wood fiber furnish subdivision of the nonintegrated-fine papers subcategory. As discussed previously, BOD_5 and TSS final effluent concentrations increase as raw waste BOD_5 concentration increases. Therefore, NSPS Option 2 final effluent concentrations for these five subcategories and for the subcategory subdivision are greater than NSPS Option 1 final effluent concentrations. Long-term average BOD_5 final effluent concentrations were based on the percent reductions in BOD_5 that are characteristic of NSPS Option 1. EPA calculated the percent BOD_5 reduction for NSPS Option 1 for each of the subcategories and subdivisions. The Agency applied these percent reductions to the NSPS Option 2 raw waste BOD_5 concentrations to develop the long-term average BOD_5 final effluent concentrations characteristic of NSPS Option 2. [This is in contrast to proposed

TABLE VIII-39

COMPARISON OF NSPS OPTION 1 RAW WASTE LOADS AND FINAL EFFLUENT LEVELS WITH NSPS OPTION 2 RAW WASTE LOADS AND FINAL EFFLUENT LEVELS

	NSPS Option 1					NSPS Option 2				
	Raw Waste			Final Effluent		Raw Waste			Final Effluent	
	Flow		BOD$_5$	BOD$_5$	TSS	Flow		BOD$_5$	BOD$_5$	TSS
	kl/kkg	kgal/t	mg/l	mg/l	mg/l	kl/kkg	kgal/t	mg/l	mg/l	mg/l
Integrated Segment										
Dissolving Kraft	230.0	(55.1)	289	21.0	35.5	211.6	(50.7)	276	21.0	35.5
Market Bleached Kraft	173.0	(41.6)	219	19.1	33.0	152.7	(36.6)	192	19.1	33.0
BCT Bleached Kraft	148.0	(35.4)	260	17.5	29.3	132.3	(31.7)	266	17.9	30.0
Alkaline-Fine[1]	129.0	(30.9)	261	15.0	23.5	104.7	(25.1)	258	15.0	23.5
Unbleached Kraft										
o Linerboard	52.5	(12.6)	322	24.5	41.6	39.2	(9.4)	316	24.5	41.6
o Bag	52.5	(12.6)	462	28.6	51.8	47.6	(11.4)	356	28.6	51.8
Semi-Chemical	42.9	(10.3)	587	27.5	51.2	30.5	(7.3)	578	27.5	51.2
Unbleached Kraft and Semi-Chemical	58.4	(14.0)	332	23.1	40.3	48.0	(11.5)	339	23.6	41.4
Dissolving Sulfite Pulp										
o Nitration	275.0	(66.0)	498	30.8	45.6	246.2	(59.0)	368	30.8	45.6
o Viscose	275.0	(66.0)	567	33.0	45.6	246.2	(59.0)	376	33.0	45.6
o Cellophane	275.0	(66.0)	659	35.8	45.6	246.2	(59.0)	445	35.8	45.6
o Acetate	303.4	(72.7)	877	41.0	41.4	274.2	(65.7)	313	41.0	41.4
Papergrade Sulfite[2]	*	*	652	32.5	42.0	*	*	650	32.5	42.0
Groundwood-Thermo-Mechanical	88.0	(21.1)	241	18.1	31.0	57.6	(13.8)	306	22.9	42.0
Groundwood-CMN Papers	99.0	(23.8)	175	15.0	22.2	70.1	(16.8)	208	17.8	28.6
Groundwood-Fine Papers	91.0	(21.9)	182	15.0	22.0	64.3	(15.4)	194	16.0	24.2
Secondary Fibers Segment										
Deink										
o Fine Papers	102.0	(24.4)	885	24.2	35.9	66.4	(15.9)	563	24.2	35.9
o Tissue Papers	102.0	(24.4)	885	32.6	44.4	81.4	(19.5)	754	32.6	44.4
o Newsprint	67.6	(16.2)	235	25.4	48.6	67.6	(16.2)	235	25.4	48.6
Tissue From Wastepaper	68.0	(16.3)	142	18.8	41.6	68.0	(16.3)	142	18.8	41.6
Paperboard From Wastepaper										
o Corrugating Medium Furnish	13.4	(3.2)	1724	84.2	90.2	13.4	(3.2)	1724	84.2	90.2
o Noncorrugating Medium Furnish	13.4	(3.2)	843	54.8	72.3	13.4	(3.2)	843	54.8	72.3
Wastepaper-Molded Products	23.8	(5.7)	229	25.0	48.3	23.8	(5.7)	229	25.0	48.3
Builders' Paper and Roofing Felt	11.3	(2.7)	577	43.6	64.2	11.3	(2.7)	577	43.6	64.2
Nonintegrated Segment										
Nonintegrated-Fine Papers										
o Wood Fiber Furnish	63.0	(15.2)	170	22.3	25.1	37.6	(9.4)	190	24.9	29.5
o Cotton Fiber Furnish	176.5	(42.3)	130	17.0	19.8	129.8	(31.2)	108	17.0	19.8
Nonintegrated-Tissue Papers	96.0	(22.9)	120	28.7	20.3	79.7	(19.1)	112	28.7	20.3
Nonintegrated-Lightweight Papers										
o Lightweight	203.2	(48.7)	107	28.5	20.1	159.4	(38.2)	83	28.5	20.1
o Electrical	320.9	(76.9)	68	28.5	20.1	278.8	(66.8)	48	28.5	20.1
Nonintegrated-Filter and Nonwoven Papers	250.0	(59.9)	49	28.5	20.1	198.2	(47.5)	45	28.5	20.1
Nonintegrated-Paperboard	53.8	(12.9)	193	28.5	20.1	46.7	(11.2)	176	28.5	20.1

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

*NSPS Option 1 and Option 2 vary with the percent sulfite pulp in the final product and are as follows:

NSPS Option 1 Flow = 52.87 exp(0.017x) kl/kkg
= 12.67 exp(0.017x) kgal/ton
NSPS Option 2 Flow = 38.06 exp(0.017x) kl/kkg
= 9.12 exp(0.017x) kgal/ton

where x equals the percent sulfite pulp produced on-site in the final product

NSPS in which the Agency assumed BOD$_5$ and TSS final effluent concentrations would be identical to those characteristic of the best performing mill option (equivalent to NSPS Option 1 in this document) even when the raw waste BOD$_5$ concentration increased after the application of production process controls.] EPA also adjusted the TSS final effluent concentrations accordingly. The methodology on which the TSS final effluent concentrations were adjusted is based on investigations conducted by McKinney. (204)

McKinney investigated the mathematics of complete-mixed activated sludge systems and developed the following relationship to determine the effluent BOD$_5$ discharged from activated sludge systems.

$$\text{Effluent BOD}_5 = F + kM_a$$

F = soluble BOD$_5$
k = metabolism constant at 20°C over a 5-day period
M_a = active or living mass of microorganisms

The constant, k, can be determined for each subcategory by plotting the final effluent BOD$_5$ concentration versus the final effluent TSS concentration for various levels of treatment. The constant is equal to the slope of the straight line defined by the above relationship. For each subcategory for which the NSPS Option 2 BOD$_5$ raw waste concentration is greater than the NSPS Option 1 BOD$_5$ raw waste concentration, EPA determined k by plotting the long-term average BOD$_5$ final effluent concentration corresponding to BPT effluent limitations and to NSPS Option 1 versus the long-term average TSS final effluent concentration corresponding to BPT effluent limitations and NSPS Option 1, respectively.

From the relationship developed by McKinney, if the increase in final effluent BOD$_5$ concentration between NSPS Option 2 and NSPS Option 1 is associated with an increase in TSS discharged (i.e., the increased BOD$_5$ is all insoluble BOD$_5$), the increase in the TSS final effluent concentration can be determined from the following relationship:

$$\Delta\text{TSS} = (\Delta\text{BOD}_5)/k$$

The NSPS Option 2 long-term average TSS final effluent concentrations for the BCT bleached kraft, unbleached kraft and semi-chemical, groundwood-TMP, groundwood-CMN papers, and groundwood-fine papers subcategories and for the wood fiber furnish subdivision of the nonintegrated-fine papers subcategory were determined based on the above relationship.

An illustration of how the Agency applied its methodology to compute long-term average BOD$_5$ and TSS effluent concentrations in those subcategories where NSPS Option 2 raw waste BOD$_5$ concentrations are greater than NSPS Option 1 raw waste BOD$_5$ concentrations is presented in Table VIII-40 and Figure VIII-2.

TABLE VIII-40

CALCULATION OF FINAL EFFLUENT LEVELS FOR SUBCATEGORIES FOR WHICH THE NSPS OPTION 2 RAW WASTE BOD5 CONCENTRATION IS GREATER THAN THE NSPS OPTION 1 RAW WASTE BOD5 CONCENTRATION

EXAMPLE: GROUNDWOOD FINE PAPERS

Sample Calculation

BOD5:

NSPS Option 1 BOD5 raw waste load (RWL) = 182 mg/l (see Table VIII-39)

NSPS Option 1 BOD5 final effluent (F.E.) = 15.0 mg/l (see Table VIII-39)

Percentage BOD5 reduction = 100 x (182 - 15.0)/182 = 91.76%

NSPS Option 2 BOD5 RWL = 194 mg/l (see Table VIII-37)

NSPS Option 2 BOD5 FE level is defined as the NSPS Option 1 percentage reduction applied to NSPS Option 2 BOD5 RWL = (194 mg/l) (1.00 - 0.9176) = 15.99 mg/l

NSPS Option 2 BOD5 long-term average final effluent load

= (NSPS Option 2 flow)x(NSPS option 2 BOD5 FE concentration)
= (64.3 kl/kkg)(15.99 mg/l) = 1028 gm/kkg
= 1.0 kg/kkg

TSS:

NSPS Option 2 TSS FE level is equal to the NSPS Option 1 TSS FE level plus ΔTSS where

ΔTSS = ΔBOD5/k

ΔBOD5 is NSPS Option 2 BOD5 FE minus NSPS Option 1 BOD5 FE

= 15.99 mg/l - 15.00 mg/l
= 0.99 mg/l

k is the constant defined by the McKinney relationship and is the slope of the FE TSS versus FE BOD5 curve for the subcategory (see Fig. VIII-2).

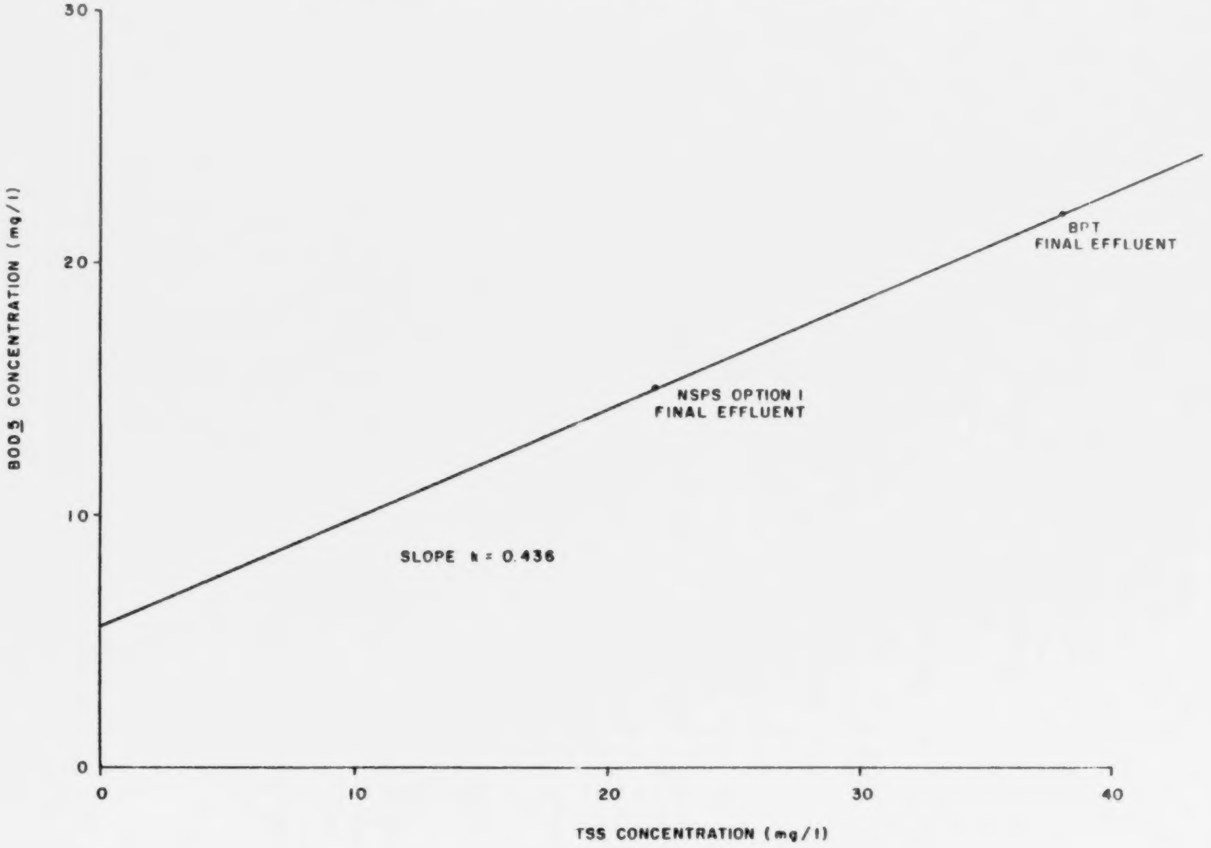
k = 0.436

NSPS Option 1 TSS FE level = 22.0 (see Table VIII-39)

NSPS Option 2 TSS FE level = NSPS Option 1 TSS FE level plus ΔBOD5/k
= 22.0 mg/l + 0.99 mg/l / 0.436
= 24.27 mg/l

NSPS Option 2 TSS long-term average final effluent load
= (NSPS Option 2 flow)x(NSPS Option 2 TSS FE concentration)
= (64.3 kl/kkg)(24.27 mg/l) = 1561 gm/kkg
= 1.6 kg/kkg

FIGURE VIII-2
FINAL EFFLUENT TSS VS FINAL EFFLUENT BOD5
FOR THE GROUNDWOOD-FINE PAPERS SUBCATEGORY



Summary of NSPS Long-Term Average Final Effluent Characteristics-Table VIII-41 presents a summary of the NSPS long-term average BOD5 and TSS effluent loads.

Attainment of NSPS Option 2

NSPS Option 2 final effluent loads have been attained in 18 of the 22 subcategories where BPT is attained and in each of the eight major industry sectors discussed earlier in this section (bleached kraft, unbleached kraft/semi-chemical, sulfite, groundwood, deink, other secondary fiber, nonintegrated-fine papers, and other nonintegrated). Table VIII-42 summarizes the number of mills attaining NSPS Option 2 final effluent loads and the number of direct discharging mills in each subcategory for which data were available. At 23 percent of the mills in the integrated segment, 60 percent of the mills in the secondary fibers segment, and 72 percent of the mills in the nonintegrated segment where BPT effluent limitations are attained, NSPS Option 2 limits are also attained.

EPA reviewed the percent reductions required to attain NSPS Option 2 effluent loads (see Table VIII-43). The percent reductions of BOD5 that form the basis of NSPS Option 2 are equal to or less than those that form the basis of NSPS Option 1. As discussed previously, these percent reductions have been attained in all of the eight major sectors of the industry.

Conventional Pollutant Variability Analysis

Pollutant quantities discharged from a wastewater treatment system vary. EPA accounts for this variability in deriving limitations regulating the amount of pollutants that may be discharged from a treatment system. The statistical procedures employed in analyzing variability for the conventional pollutants, BOD5 and TSS, regulated under NSPS for the pulp, paper, and paperboard industry are described below.

Effluent Limitations Guidelines. An effluent limitation is an upper bound on the amount of pollutant discharge allowed per day or average of 30 days. The limitations are determined by calculating the product of two numbers which may be derived from effluent data: one is referred to as a variability factor and the other is referred to as a long-term average. Two types of variability factors are derived for the guidelines: a daily maximum factor and a 30-day maximum factor. The daily maximum factor is the ratio of (a) a value that would be exceeded rarely by the daily pollutant discharge to (b) the long-term average daily discharge. The 30-day maximum factor is the ratio of (a) a value that would be exceeded rarely by the average of 30 daily discharge measurements to (b) the long-term average daily discharge. The long-term average daily discharge quantity is an expression of the long-run performance of the treatment or discharge process in units of average daily kilograms (pounds) of pollutant discharged. Given a daily maximum variability factor for a pollutant (denoted by VF) and a long-term average for the same pollutant (denoted by LTA), the daily

TABLE VIII-41

NSPS OPTION 2
LONG-TERM AVERAGE
DISCHARGE CHARACTERISTICS

	Flow		BOD5		TSS	
	kl/kkg	(kgal/t)	kg/kkg	(lb/t)	kg/kkg	(lb/t)
Integrated Segment						
Dissolving Kraft	211.6	(50.7)	4.4	(8.87)	7.5	(15.03)
Market Bleached Kraft	152.7	(36.6)	2.9	(5.82)	5.0	(10.06)
BCT Bleached Kraft	132.3	(31.7)	2.4	(4.73)	4.0	(7.94)
Alkaline-Fine[1]	104.7	(25.1)	1.6	(3.14)	2.5	(4.92)
Unbleached Kraft						
o Linerboard	39.2	(9.4)	0.96	(1.92)	1.6	(3.26)
o Bag	47.6	(11.4)	1.4	(2.71)	2.5	(4.92)
Semi-Chemical	30.5	(7.3)	0.8	(1.67)	1.6	(3.12)
Unbleached Kraft and Semi-Chemical	48.0	(11.5)	1.1	(2.26)	2.0	(3.97)
Dissolving Sulfite Pulp						
o Nitration	246.2	(59.0)	7.6	(15.16)	11.2	(22.42)
o Viscose	246.2	(59.0)	8.1	(16.22)	11.2	(22.42)
o Cellophane	246.2	(59.0)	8.8	(17.61)	11.2	(22.42)
o Acetate	274.2	(65.7)	11.2	(22.48)	11.3	(22.66)
Papergrade Sulfite[2]	*	*	*	*	*	*
Groundwood-Thermo-Mechanical	57.6	(13.8)	1.3	(2.64)	2.4	(4.84)
Groundwood-CMN Papers	70.1	(16.8)	1.3	(2.50)	2.0	(4.01)
Groundwood-Fine Papers	64.3	(15.4)	1.0	(2.05)	1.6	(3.11)
Secondary Fibers Segment						
Deink						
o Fine Papers	66.4	(15.9)	1.6	(3.21)	2.4	(4.76)
o Tissue Papers	81.4	(19.5)	2.7	(5.31)	3.6	(7.22)
o Newsprint	67.6	(16.2)	1.7	(3.43)	3.3	(6.57)
Tissue From Wastepaper	68.0	(16.3)	1.3	(2.56)	2.8	(5.66)
Paperboard From Wastepaper						
o Corrugating Medium Furnish	13.4	(3.2)	1.1	(2.25)	1.2	(2.41)
o Noncorrugating Medium Furnish	13.4	(3.2)	0.73	(1.46)	0.97	(1.93)
Wastepaper-Molded Products	23.8	(5.7)	0.60	(1.19)	1.2	(2.30)
Builders' Paper and Roofing Felt	11.3	(2.7)	0.49	(0.98)	0.73	(1.45)
Nonintegrated Segment						
Nonintegrated-Fine Papers						
o Wood Fiber Furnish	37.6	(9.4)	0.98	(1.96)	1.2	(2.31)
o Cotton Fiber Furnish	129.8	(31.1)	2.2	(4.42)	2.6	(5.15)
Nonintegrated-Tissue Papers	79.7	(19.1)	2.3	(4.58)	1.6	(3.24)
Nonintegrated-Lightweight Papers						
o Lightweight	159.4	(38.2)	4.5	(9.07)	3.2	(6.40)
o Electrical	278.8	(66.8)	7.9	(15.86)	5.6	(11.19)
Nonintegrated-Filter and Nonwoven Papers	198.2	(47.5)	5.6	(11.28)	4.0	(7.95)
Nonintegrated-Paperboard	46.7	(11.2)	1.3	(2.66)	0.94	(1.88)

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

*NSPS vary with the percent sulfite pulp in the final product. These equations can be used to obtain annual average effluent characteristics for Papergrade Sulfite mills:

Flow (kl/kkg) = 38.06 exp(0.017x)
BOD5 (kg/kkg) = 1.24 exp(0.017x)
TSS (kg/kkg) = 1.60 exp(0.017x)

where x equals the percent sulfite pulp produced on-site in the final product.

TABLE VIII-42

NUMBER OF MILLS ATTAINING BPT AND NSPS OPTION 2 FINAL EFFLUENT LEVELS

Integrated Segment	Mills with Available Data	Mills Attaining BPT F.E. levels(a)	Mills Attaining NSPS Option 2 F.E. levels(a)
Dissolving Kraft	3	2	1
Market Bleached Kraft	9	7	1
BCT Bleached Kraft	7	3	0
Alkaline-Fine[1]	14	5	1
Unbleached Kraft			
o Linerboard	16	9	1
o Bag	10	3	1
Semi-Chemical	15	4	1
Unbleached Kraft and Semi-Chemical	9	3	1
Dissolving Sulfite Pulp			
o Nitration	0	0	0
o Viscose	2	0	0
o Cellophane	1	0	0
o Acetate	2	0	0
Papergrade Sulfite[2]	11	5	2
Groundwood-Thermo-Mechanical	2	1	0
Groundwood-CMN Papers	2	1	0
Groundwood-Fine Papers	6	5	2
Secondary Fibers Segment			
Deink			
o Fine Papers	3	3	0
o Tissue Papers	10	6	2
o Newsprint	1	1	1
Tissue From Wastepaper	9	7	2
Paperboard From Wastepaper			
o Corrugating Medium Furnish	3	2	1
o Noncorrugating Medium Furnish	37	21	18
Wastepaper-Molded Products	4	1	0
Builders' Paper and Roofing Felt	5	4	3
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	12	5	1
o Cotton Fiber Furnish	2	1	0
Nonintegrated-Tissue Papers	14	9	6
Nonintegrated-Lightweight Papers			
o Lightweight	7	6	6
o Electrical	2	2	2
Nonintegrated-Filter and Nonwoven Papers	4	4	4
Nonintegrated-Papberboard	5	2	2

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

(a) F.E. = Final Effluent

TABLE VIII-43

PERCENT REDUCTIONS REQUIRED TO ATTAIN NSPS OPTION 2 BOD_5 FINAL EFFLUENT CHARACTERISTICS FROM NSPS OPTION 2 BOD_5 RAW WASTE LOADS

Integrated Segment	Percent Reduction*
Dissolving Kraft	92
Market Bleached Kraft	90
BCT Bleached Kraft	93
Alkaline-Fine[1]	94
Unbleached Kraft	
o Linerboard	92
o Bag	92
Semi-Chemical	95
Unbleached Kraft and Semi-Chemical	93
Dissolving Sulfite Pulp	
o Nitration	92
o Viscose	91
o Cellophane	92
o Acetate	93
Papergrade Sulfite[2]	95
Groundwood-Thermo-Mechanical	93
Groundwood-CMN Papers	91
Groundwood-Fine Papers	92
Secondary Fibers Segment	
Deink	
o Fine Papers	96
o Tissue Papers	96
o Newsprint	89
Tissue From Wastepaper	87
Paperboard From Wastepaper	
o Corrugating Medium Furnish	95
o Noncorrugating Medium Furnish	94
Wastepaper-Molded Products	89
Builders' Paper and Roofing Felt	92
Nonintegrated Segment	
Nonintegrated-Fine Papers	
o Wood Fiber Furnish	87
o Cotton Fiber Furnish	84
Nonintegrated-Tissue Papers	74
Nonintegrated-Lightweight Papers	
o Lightweight	66
o Electrical	40
Nonintegrated-Filter and Nonwoven Papers	37
Nonintegrated-Paperboard	84

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

*Percent reduction
= [raw waste load (lb/t) - final effluent (lb/t)] x 100/raw waste load (lb/t) except for Papergrade Sulfite subcategories for which percent reduction is defined in terms of concentrations (mg/l).

limitation is the product of the variability factor and the long-term average (VF x LTA). Similarly, given a 30-day maximum variability factor (VF_{30}), the limit for the average of 30 daily observations is VF_{30} x LTA.

Daily Maximum Variability Factors. Historically, in this industry, the daily maximum variability factor has been defined as the ratio of an estimated 99th percentile of the distribution of daily pollutant discharge values to the estimated long-term average daily pollutant discharge. The 99th percentile of daily pollutant discharge represents a pollutant discharge value below which 99 percent of all pollutant discharge values fall. Estimates of the 99th percentile of daily pollutant discharge distribution may be calculated from available effluent data. Percentiles may be estimated using either a parametric or nonparametric approach. To utilize a parametric approach, a distribution with a known functional form is fit to the data. Past guideline development has utilized such distributions as the normal, lognormal, and three-parameter lognormal distributions. If a distribution is found to describe the data adequately, a 99th percentile can be calculated through the use of the known functional form of the assumed distribution.

Nonparametric methods may also be used to estimate distribution percentiles. Such methods do not require that the particular form of the underlying distribution be known, and make no restrictive assumptions about the distributional form of the data. (Nonparametric methods are discussed in many texts. See, for example, J. D. Gibbons, Nonparametric Statistical Inference, McGraw-Hill (1971).(205)) EPA has applied nonparametric methods to pulp, paper, and paperboard industry effluent data to obtain 50 percent confidence level (or tolerance level) estimates of the 99th percentile of the distribution of daily pollutant discharge. That is, an estimate of the 99th percentile was determined such that the probability that the estimate (which is of the form: the rth largest of n measurements) is greater than or equal to the 99th percentile of the daily pollutant discharge (denoted as $K_{.99}$) is no less than 0.5. That is, n daily pollutant discharge values were obtained and ordered from smallest to largest in value. The rth smallest pollutant discharge value (where r is less than or equal to n), denoted by $X(\underline{r})$, is chosen such that the probability that $X(\underline{r})$ is greater than or equal to $K_{.99}$ is at least 0.5 (i.e., $P[X(r) \geq K_{.99}] \geq 0.5$). Utilizing this approach, the value of r is determined such that

$$P[X_{(r)} \geq K_{.99}] = 1-P[X_{(r)} < K_{.99}] = 1-\sum_{i=r}^{n}\binom{n}{i} p^{i} \quad (1-p)^{n-i} \geq 0.5$$

where p = .99

and $\binom{n}{i} = \frac{n!}{i!\,(n-i)!}$

The estimate is interpreted as the value below which 99 percent of the values of a future sample of size n will fall with a probability of at least 0.5.

Analysis of Daily Pollutant Discharge Values To Determine Daily Maximum Variability Factors - Daily measurements for the conventional pollutants, BOD$_5$ and TSS, were submitted by mill representatives. Values for facilities employing primary and/or biological treatment were obtained through the supplemental data request program. Values for facilities employing chemically assisted clarification were obtained through the supplemental data request program and the verification sampling program. These values were used to calculate daily maximum variability factors and 30-day maximum variability factors.

Initially, a parametric approach toward estimation of the 99th percentile of daily pollutant discharge values was considered. Mill-specific daily pollutant discharge values for BOD$_5$ and TSS were fit to hypothesized normal and lognormal distributions. To assess whether mill-specific sets of daily pollutant values could be adequately described by the normal or lognormal distributions, Kolmogorov-Smirnov goodness-of-fit tests and frequency histograms were performed. The goodness-of-fit tests indicated that, in general, neither the normal nor lognormal distribution adequately represent the mill-specific daily pollutant discharge values of BOD$_5$ and TSS. Because of these results, EPA decided to use nonparametric estimates of the 99th percentile of the daily data. The 50 percent tolerance level criterion described above was used to estimate the 99th percentile. Mill-specific daily maximum variability factors were determined by calculating the ratio of the 99th percentile estimates to the average of the daily discharge values. The effects of daily dependence were examined using a time series model that was developed for the timber products point source category (see *Final Development Document for Effluent Limitations Guidelines and Standards for the Timber Products Point Source Category*, USEPA, Washington, D.C., January 1981 (206)). The results show that maximum day variability factors are relatively insensitive to daily dependence and that the nonparametric methods used yield representative variability factors for data examined in this study.

This is further supported by additional analyses conducted by the Agency. On a mill-specific basis, each daily value was compared to the corresponding mill-specific 99th percentile estimate. Table VIII-44 displays the aggregate results of comparing each daily value to its corresponding 99th percentile estimate of the daily maximum discharges of BOD$_5$ and TSS. The percentage of daily values exceeding the 99th percentile estimate is substantially the same as the expected one percent. Table VIII-45 displays mill-specific values for maximum

TABLE VIII-44

DISTRIBUTION OF DAILY VALUES ABOUT THE ESTIMATE OF THE 99th PERCENTILE

	Percentage of Points ≤99th Percentile	Percentage of Points >99th Percentile	Totals
TSS	99.2% (29,755)*	0.8% (247)*	100.0% (30,002)*
BOD_5	99.2% (28,860)*	0.8% (244)*	100.0% (29,104)*

* Actual number of daily data points given in parentheses.

TABLE VIII-45
VARIABILITY FACTORS FOR DETERMINING MAXIMUM DAY LIMITATIONS(a)

BIOLOGICAL TREATMENT: SUBSETS (1), (2), (3), AND (4)
PRIMARY CLARIFICATION: SUBSETS (5) AND (6)
CHEMICALLY ASSISTED CLARIFICATON: SUBSET (7)

Mill Number	BOD5 Number of Data Points	BOD5 Maximum Day Average	TSS Number of Data Points	TSS Maximum Day Average	Mills Used to Calculate Averages by Subsets (1)(2)(3)(4)(5)(6)
MILLS WITH BIOLOGICAL TREATMENT					
032002	1,000*	2.00	1,003*	2.41	(1)(2)(3)(4)
032003	875*	2.15	837*	2.12	(1)
030005	859	3.11	881	2.04	(1)
030032	916*	2.17	55*	(b)	(1)(2)(3)
030046	721*	2.83	730*	4.16	(1)(2)(3)
030027	986*	3.42	992*	4.76	(1)(2)(3)(4)
030020	1,002*	2.64	998*	2.26	(1)(2)(3)(4)
010002	568*	1.80	630*	1.52	(1)(2)(3)
010019	429*	2.99	424*	2.25	(1)(2)(3)
010005	1,004	3.32	1,004	2.46	(1)
020017	914	2.75	914	2.17	(1)(2)(3)
020009	332	2.52	341	2.46	(1)
060004	957*	1.94	956*	2.87	(1)(2)(3)
015001	642	3.39	652	2.76	(1)(2)(3)
015001	97*	2.72	104*	2.47	(1)(2)(3)
040012	522*	2.56	610*	1.90	(1)
040009	759*	2.05	759*	2.17	(1)(2)(3)
040019	127	3.70	303	2.91	(1)(2)(3)(4)
040010	369	2.27	369	1.97	(1)(2)(3)
040010	541*	1.57	541*	2.32	(1)(2)(3)
070001	926	3.88	971	5.98	(1)(2)(3)
054015	993*	3.74	954*	4.78	(1)
052008	952*	6.73	961*	5.93	(1)(2)(3)(4)
030044	693*	1.86	701*	2.34	(1)(2)(3)
140007	778*	4.79	779*	7.40	(1)(2)(3)
140019	982*	3.61	983*	3.76	(1)(2)(3)(4)
140015	153	2.54	153	2.36	(1)(2)(3)(4)
140015	710*	3.28	710*	3.65	(1)(2)(3)
140021	119	5.34	119	2.61	(1)(2)(3)(4)
140021	409*	2.94	409*	2.99	(1)(2)(3)(4)
140025	295*	2.29	740*	1.73	(1)(2)(3)
140030	999*	3.25	999*	4.29	(1)(2)(3)(4)
100005	141*	4.42	357	3.68	(1)(2)(3)(4)
090004	999	2.56	999	2.94	(1)(2)(3)
110077	373	3.29	279	2.70	(1)(2)(3)(4)
110031	421*	4.49	418*	4.42	(1)(2)(3)(4)
080041	968	2.56	974	4.27	(1)(2)(3)
080046	396*	1.94	396*	1.98	(1)(2)(3)(4)

TABLE VIII-45 (cont.)

MILLS WITH PRIMARY CLARIFICATION					
090008	964*	1.92	976*	5.49	(5)(6)
090019	797	1.80	797	2.59	(5)
090019	181*	1.76	181*	2.09	(5)
090022	52	(b)	368	3.36	(5)
090022	85*	(b)	595*	2.68	(5)
080022	898*	3.47	898*	2.85	(5)(6)
105020	354	4.36	354	4.01	(5)(6)
105020	440*	3.75	440*	2.93	(5)(6)
MILLS WITH CHEMICALLY ASSISTED CLARIFICATION					
060001	381*	2.83	379*	2.39	(7)
080027	456*	2.56	454*	2.92	(7)

*Denotes refrigerated data

(a)Subset Descriptions:

(1)All mills with biological treatment.
(2)Mills with biological treatment; final effluent levels at or better than BPT.
(3)Mills with biological treatment; final effluent levels at or better than BPT. Biological treatment is the technology basis of BPT effluent limits.
(4)Mills with biological treatment; final effluent levels at or better than NSPS Option 1 levels. Biological treatment is the technology basis of BPT effluent limits.
(5)Mills with primary treatment; final effluent levels at or better than BPT limits. Primary clarification is the technology basis of BPT effluent limits.
(6)Mills with primary treatment; final effluent levels at or better than NSPS Option 1 levels. Primary clarification is the technology basis of BPT effluent limits.
(7)All mills with chemically assisted clarification.

(b)Insufficient data for analysis.

day variability factors for BOD5 and TSS, obtained by calculating the quotient of the 99th percentile estimates and long-term average pollutant values.

30-Day Maximum Variability Factors. The approach for deriving 30-day maximum variability factors is suggested by a statistical result known as the Central Limit Theorem. This theorem states that the distribution of a mean of a sample of size n drawn from any one of a large class of different distributional forms will be approximately normally distributed. For practical purposes, the normal distribution provides a good approximation to the distribution of the sample mean for samples as small as 25 or 30 (see e.g., Miller and Freund, Probability and Statistics for Engineers, Prentice - Hall, 1965, pp. 132-34).(207)

Analysis of 30-Day Averages of Pollutant Discharge Values To Determine 30-Day Maximum Variability Factors - The mill-specific data for each pollutant were divided into periods with 30 days of measurements. These periods were constructed without regard to whether the days fell into a calendar month period or whether measurements on adjacent days were available. For instance, if 30 daily measurements were available from January 1 to February 15, these 30 measurements were used to construct one 30-day average to be included in the analysis. If the next 30 measurements were available during February 16 to March 25, these would constitute the next 30-day average and so on. The mill-specific 30-day averages so constructed were found to fit the normal distribution adequately on the basis of goodness-of-fit tests. These tests were performed using the mean of the 30-day means and the standard deviation of the 30-day means to estimate the mean and standard deviation of the hypothesized distribution. The results of the goodness-of-fit tests are summarized in Table VIII-46 and are consistent with the Central Limit Theorem. Using X_{30} and S_{30} to denote the mean and standard deviation of the 30-day averages, respectively, for a particular mill, the 99th percentiles were estimated as $X_{30} + 2.33 S_{30}$.

EPA also examined the effects of daily dependence, monthly dependence, and seasonality using a time series model. A simpler version of this time series model was used to determine maximum 30-day average variability in establishing effluent limitations guidelines and standards for the Timber Products Processing Point Source Category (see Final Development Document for Effluent Limitations Guidelines and Standards for the Timber Products Point Source Category," U.S. Environmental Protection Agency, Washington, D.C., January 1981 (206)). The results show that, although seasonality has the most important effect on maximum 30-day average variability factors, the method used in this study for estimating 99th percentiles accounts for seasonality and provides representative maximum 30-day average variability factors.

This is further supported by additional analyses conducted by the Agency. On a mill-specific basis, each 30-day average was compared to the corresponding mill-specific 99th percentile estimate. Table

TABLE VIII-46

RESULTS OF GOODNESS-OF-FIT TESTS FOR SUCCESSIVE 30-DAY AVERAGES(a)

		BOD5				TSS			
Subcategory Name	Mill Number	Number of Means	Test Statistic	Critical Value at α = .01	Decision(b)	Number of Means	Test Statistic	Critical Value at α = .01	Decision(b)
Dissolving Kraft	032002*	33	0.0530	0.1795	NS	33	0.1085	0.1795	NS
	032003*	29	0.0899	0.1896	NS	27	0.0719	0.1948	NS
Market Bleached Kraft	030005	28	0.2274	0.1922	Sig α = 0.01	29	0.1289	0.1896	NS
BCT Bleached Kraft	030032*	30	0.1045	0.1870	NS	1	-	-	-(c)
Alkaline-Fine(d)	030046*	24	0.2295	0.2062	Sig α = 0.01	24	0.2715	0.2062	Sig α = 0.01
	030027*	32	0.0949	0.1823	NS	33	0.1840	0.1795	Sig α = 0.01
	030020*	33	0.1647	0.1795	NS	33	0.0718	0.1795	NS
Unbleached Kraft									
o Linerboard	010002*	18	0.1593	0.2390	NS	21	0.1376	0.2248	NS
	010019*	14	0.1801	0.2610	NS	14	0.1989	0.2610	NS
o Bag	010005	33	0.1679	0.1795	NS	33	0.1815	0.1795	Sig α = 0.01
Semi-Chemical	020017	30	0.1272	0.1870	NS	30	0.1234	0.1870	NS
	020009	11	0.1782	0.2840	NS	11	0.2581	0.2840	NS
	060004*	31	0.0904	0.1852	NS	31	0.0984	0.1852	NS
Unbleached Kraft and Semi-Chemical	015001	21	0.2332	0.2248	Sig α = 0.01	21	0.1180	0.2248	NS
	015001*	3	-	-	-(c)	3	-	-	-(c)
Papergrade Sulfite(f)	040012*	17	0.2398	0.2450	NS	20	0.1270	0.2310	NS
	040009*	25	0.1207	0.2000	NS	25	0.1820	0.2000	NS
	040019	4	-	-	-(c)	10	0.2316	0.2940	NS
	040010	12	0.1672	0.2750	NS	12	0.2321	0.2750	NS
	040010*	18	0.0684	0.2390	NS	18	0.2044	0.2390	NS
Groundwood-Fine Papers	052008*	30	0.2569	0.1852	Sig α = 0.01	32	0.1480	0.1823	NS
Groundwood-Thermo-Mechanical	070001	30	0.1407	0.1870	NS	32	0.1622	0.1823	NS
Groundwood-CMN Papers	054015*	33	0.0777	0.1795	NS	31	0.1502	0.1852	NS
Integrated Miscellaneous	030044*	23	0.0808	0.2124	NS	23	0.1819	0.2124	NS
	060001*	12	0.2234	0.2750	NS	12	0.2248	0.2750	NS
Deink									
o Fine Papers	140007*	25	0.2416	0.2000	Sig α = 0.01	25	0.2020	0.2000	Sig α = 0.01
	140019*	32	0.1483	0.1823	NS	32	0.1183	0.1823	NS

TABLE VIII-46 (cont.)

o Tissue Papers	140015	5	0.1679	0.4050	NS	5	0.1427	0.4050	NS
	140015*	23	0.2082	0.2124	NS	23	0.1410	0.2124	NS
	140021	3	-	-	-(c)	3	-	-	-(c)
	140021*	13	0.1681	0.2680	NS	13	0.1518	0.2680	NS
	140025*	9	0.1469	0.3110	NS	24	0.0981	0.2062	NS
	140030*	33	0.1826	0.1795	Sig α = 0.01	33	0.1526	0.1795	NS
Tissue From Wastepaper	100005**	4	-	-	-(c)	11	0.1966	0.2840	NS
	090004	33	0.0896	0.1795	NS	33	0.1499	0.1795	NS
Paperboard From Wastepaper	110077	12	0.2026	0.2750	NS	9	0.1320	0.3110	NS
	110031*	14	0.2303	0.2610	NS	13	0.2212	0.2680	NS
Nonintegrated-Fine Papers	080041	32	0.1606	0.1823	NS	32	0.1173	0.1823	NS
	080046*	13	0.1270	0.2680	NS	13	0.2576	0.2680	NS
	080027*	14	0.2383	0.2610	NS(e)	15	0.2009	0.2570	NS
Nonintegrated-Tissue Papers	090008*	32	0.1333	0.1823	NS	32	0.2080	0.1823	Sig α = 0.01
	090019	26	0.1243	0.1974	NS	26	0.0781	0.1974	NS
	090019*	6	0.1816	0.3640	NS	6	0.2375	0.3640	NS
	090022	1	-	-	-(c)	12	0.1178	0.2750	NS
	090022*	2	-	-	-(c)	19	0.0974	0.2350	NS
Nonintegrated-Lightweight Papers									
o Lightweight	080022*	29	0.1050	0.1896	NS	29	0.1371	0.1896	NS
	105020	11	0.1801	0.2840	NS	11	0.2010	0.2840	NS
	105020*	14	0.1277	0.2610	NS	14	0.1749	0.2610	NS

---

*Refrigerated BOD5 and TSS data.
**Refrigerated BOD5 data only.

(a)Lilliefors, H., "On the Kolmogorov-Smirnov Tests for Normality with Mean and Variance Unknown," J. Am. Statistical Assoc., Vol. 62, 1967. (208)

(b)Reject H_o at the level α if test statistic exceeds critical value for the particular sample size N. NS denotes hypothesis test results not significant (i.e., do not reject H_o: data comes from a normal distribution).

(c)Insufficient data for analysis.

(d)Includes Fine Bleached Kraft and Soda subcategories.

(e)Although the set of successive 30-day averages was not found to be normally distributed, the set of successive 31-day averages was found to be normally distributed using the Lilliefors Test.

(f)Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

VIII-47 displays the aggregate results of comparing each 30-day average to its corresponding 99th percentile estimate of the distribution of 30-day averages of pollutant values for BOD_5 and TSS. The percentage of 30-day averages exceeding the 99th percentile estimate is substantially the same as the expected one percent. Table VIII-48 displays mill-specific maximum 30-day average variability factors for BOD_5 and TSS, obtained by calculating the quotient of the 99th percentile estimates and long-term average pollutant values.

Establishment of Variability Factors To Be Applied for Rulemaking (Biological Treatment). Tables VIII-45 and VIII-48 present the individual mills' 30-day average and daily maximum variability factors for BOD_5 and TSS for those mills with biological treatment systems. For many subcategories, biological treatment is the technology basis for achieving the effluent reduction required under NSPS guidelines. Variability factors compiled for each mill were averaged across mills and one daily and one 30-day average variability factor were determined for BOD_5 and TSS. These two variability factors were used in the establishment of 30-day average and daily maximum effluent limitations controlling the discharge of conventional pollutants from those subcategories where biological treatment forms the technology basis.

Minimum, maximum, and average variability factors were determined for each of four subsets of mills. These subsets were developed from a group of mills with biological treatment systems and are as follows:

Subset Number	Subset Description
(1)	Mills with biological treatment systems.
(2)	Mills with biological treatment systems and effluent levels at or better than BPT limitations. Biological treatment is not necessarily the treatment technology on which BPT is based for some of these mills (i.e., primary treatment forms the basis of BPT effluent limitations applicable to discharges from some of these mills).
(3)	Mills with biological treatment systems and effluent levels at or better than BPT. Biological treatment is the technology on which BPT effluent limitations are based for these mills.
(4)	Mills with biological treatment systems and effluent levels at or better than NSPS Option 1 long-term average effluent loads. Biological treatment is the technology on which BPT effluent limitations are based for these mills.

TABLE VIII-47

DISTRIBUTION OF 30-DAY AVERAGES ABOUT THE ESTIMATE OF THE 99th PERCENTILE

	Percentage of Points ≦99th Percentile	Percentage of Points >99th Percentile	Totals
TSS	98.2% (961)*	1.8% (18)*	100.0% (979)
BOD_5	98.1% (930)*	1.9% (18)*	100.0% (948)

* Actual number of successive 30-day averages given in parentheses.

TABLE VIII-48
VARIABILITY FACTORS FOR DETERMINING MAXIMUM 30-DAY LIMITATIONS(a)

BIOLOGICAL TREATMENT: SUBSETS (1), (2), (3) AND (4)
PRIMARY CLARIFICATION: SUBSETS (5) AND (6)
CHEMICALLY ASSISTED CLARIFICATON: SUBSET (7)

Mill Number	BOD5 Number of Data Points	BOD5 Maximum 30-Day Average	TSS Number of Data Points	TSS Maximum 30-Day Average	Mills Used to Calculate Averages by Subsets (1)(2)(3)(4)(5)(6)
MILLS WITH BIOLOGICAL TREATMENT					
032002	1,000*	1.49	1,003*	1.50	(1)(2)(3)(4)
032003	875*	1.56	837*	1.39	(1)
030005	859	2.02	881	1.39	(1)
030032	916*	1.86	55*	(b)	(1)(2)(3)
030046	721*	2.00	730*	2.52	(1)(2)(3)
030027	986*	1.47	992*	2.14	(1)(2)(3)(4)
030020	1,002*	1.73	998*	1.55	(1)(2)(3)(4)
010002	568*	1.56	630*	1.38	(1)(2)(3)
010019	429*	1.68	424*	1.35	(1)(2)(3)
010005	1,004	2.00	1,004	2.00	(1)
020017	914	2.02	914	1.81	(1)(2)(3)
020009	332	1.65	341	1.52	(1)
060004	957*	1.46	956*	1.79	(1)(2)(3)
015001	642	2.55	652	2.11	(1)(2)(3)
015001	97*	(b)	104*	(b)	(1)(2)(3)
040012	522*	1.76	610*	1.56	(1)
040009	759*	1.51	759*	1.66	(1)(2)(3)
040019	127	(b)	303	1.94	(1)(2)(3)(4)
040010	369	1.91	369	1.49	(1)(2)(3)
040010	541*	1.30	541*	1.49	(1)(2)(3)
070001	926	1.89	971	2.25	(1)(2)(3)
054015	993*	2.12	954*	2.22	(1)
052008	952*	2.82	961*	2.43	(1)(2)(3)(4)
030044	693*	1.34	701*	1.46	(1)(2)(3)
140007	778*	2.42	779*	2.52	(1)(2)(3)
140019	982*	2.09	983*	1.65	(1)(2)(3)(4)
140015	153	1.77	153	1.40	(1)(2)(3)(4)
140015	710*	1.80	710*	1.94	(1)(2)(3)
140021	119	(b)	119	(b)	(1)(2)(3)(4)
140021	409*	1.71	409*	1.63	(1)(2)(3)(4)
140025	295*	1.58	740*	1.28	(1)(2)(3)
140030	999*	2.08	999*	2.24	(1)(2)(3)(4)
100005	141*	(b)	356	2.35	(1)(2)(3)(4)
090004	999	2.11	999	2.02	(1)(2)(3)
110077	373	2.08	279	1.82	(1)(2)(3)(4)
110031	421*	2.37	418*	2.44	(1)(2)(3)(4)
080041	968	1.85	974	2.08	(1)(2)(3)
080046	396*	1.39	396*	1.53	(1)(2)(3)(4)

TABLE VIII-48 (cont.)

MILLS WITH PRIMARY CLARIFICATION

090008	964*	1.32	976*	1.92	(5)(6)
090019	797	1.45	797	1.44	(5)
090019	181*	1.53	181*	1.29	(5)
090022	52	(b)	368	1.30	(5)
090022	85*	(b)	595*	1.33	(5)
080022	898*	1.64	898*	1.46	(5)(6)
105020	354	1.62	354	1.86	(5)(6)
105020	440*	1.48	440*	1.55	(5)(6)

MILLS WITH CHEMICALLY ASSISTED CLARIFICATION

060001	381*	2.05	379*	1.41	(7)
080027	456*	2.10	454*	2.15	(7)

---

*Denotes refrigerated data

(a)Subset Descriptions:

(1)All mills with biological treatment.
(2)Mills with biological treatment; final effluent levels at or better than BPT.
(3)Mills with biological treatment; final effluent levels at or better than BPT. Biological treatment is the technology basis of BPT effluent limits.
(4)Mills with biological treatment; final effluent levels at or better than NSPS Option 1 levels. Biological treatment is the technology basis of BPT effluent limits.
(5)Mills with primary treatment; final effluent levels at or better than BPT limits. Primary clarification is the technology basis of BPT effluent limits.
(6)Mills with primary treatment; final effluent levels at or better than NSPS Option 1 levels. Primary clarification is the technology basis of BPT effluent limits.
(7)All mills with chemically assisted clarification.

(b)Insufficient data for analysis.

Maximum daily and maximum 30-day average variability factors for these four subsets are shown in Table VIII-49. Based on the results, where biological treatment is the basis of NSPS technology options, EPA has based the 30-day average and daily maximum effluent limitations for BOD5 and TSS on the 30-day average and daily maximum variability factors developed for subset (4), using refrigerated data, because (a) subset (4) most resembles treatment system performance that will be required of new sources and (b) refrigeration of samples will be required by permitting authorities.

Hence, for BOD5 and TSS, the 30-day average and daily maximum variability factors to be applied for those technology options where biological treatment is the technology basis are as follows:

30-Day Average Variability Factors
(From Mills with Biological Treatment)

BOD5 = 1.91
TSS = 1.90

Daily Maximum Variability Factors
(From Mills with Biological Treatment)

BOD5 = 3.54
TSS = 3.64

Establishment of Variability Factors To Be Applied For Rulemaking (Primary Treatment). Wastewater data from mills where primary clarification is employed were also collected as part of the supplemental data request program. Daily maximum and maximum 30-day variability factors for subcategories with such treatment were determined using the methods described previously and applied to data from mills with biological treatment systems.

Tables VIII-45 and VIII-48 present mill-specific daily maximum and 30-day average variability factors, respectively. Table VIII-49 presents maximum, minimum, and average variability factors for BOD5 and TSS for those mills with primary clarification. For the nonintegrated subcategories, with the exception of the nonintegrated-fine papers subcategory, primary clarification is the technology basis for both NSPS technology options considered. Variability factors for each mill were averaged and applicable daily maximum and 30-day average BOD5 and TSS variability factors were determined.

TABLE VIII-49
AVERAGE MAXIMUM 30-DAY AND MAXIMUM DAY
VARIABILITY FACTORS FOR SUBSETS (1), (2), (3), (4), (5), (6), and (7)

Subset	BOD5 Maximum 30-Day Average	BOD5 Maximum Day Average	TSS Maximum 30-Day Average	TSS Maximum Day Average
(1) ALL MILLS WITH BIOLOGICAL TREATMENT				
(A) With Refrigerated Sample Collection				
Minimum	1.30	1.57	1.28	1.52
Maximum	2.82	6.73	2.52	7.40
Average	1.79	2.97	1.80	3.24
(B) With Unrefrigerated Sample Collection				
Minimum	1.65	2.27	1.39	1.97
Maximum	2.55	5.34	2.35	5.98
Average	1.99	3.17	1.86	2.95
(2) MILLS WITH BIOLOGICAL TREATMENT; FINAL EFFLUENT LEVELS AT OR BETTER THAN BPT				
(A) With Refrigerated Sample Collection				
Minimum	1.30	1.57	1.28	1.52
Maximum	2.82	6.73	2.52	7.40
Average	1.78	2.99	1.82	3.28
(B) With Unrefrigerated Sample Collection				
Minimum	1.77	2.27	1.40	1.97
Maximum	2.55	5.34	2.35	5.98
Average	2.02	3.23	1.93	3.12
(3) MILLS WITH BIOLOGICAL TREATMENT; FINAL EFFLUENT LEVELS AT OR BETTER THAN BPT. BIOLOGICAL TREATMENT IS THE TECHNOLOGY BASIS OF BPT EFFLUENT LIMITS				
(A) With Refrigerated Sample Collection				
Minimum	1.30	1.57	1.28	1.52
Maximum	2.82	6.73	2.52	7.40
Average	1.78	2.99	1.82	3.28
(B) With Unrefrigerated Sample Collection				
Minimum	1.77	2.27	1.40	1.97
Maximum	2.55	5.34	2.35	5.98
Average	2.02	3.23	1.93	3.12
(4) MILLS WITH BIOLOGICAL TREATMENT; FINAL EFFLUENT LEVELS AT OR BETTER THAN NSPS OPTION 1 LEVELS. BIOLOGICAL TREATMENT IS THE TECHNOLOGY BASIS OF BPT EFFLUENT LIMITS				
(A) With Refrigerated Sample Collection				
Minimum	1.39	1.93	1.50	1.98
Maximum	2.82	6.73	2.44	5.93
Average	1.91	3.54	1.90	3.65
(B) With Unrefrigerated Sample Collection				
Minimum	1.77	2.54	1.40	2.36
Maximum	2.08	5.34	2.35	3.68
Average	1.93	3.72	1.88	2.85

TABLE VIII-49 (cont.)

(5) MILLS WITH PRIMARY CLARIFICATION; FINAL EFFLUENT LEVELS AT OR BETTER THAN BPT LIMITS. PRIMARY CLARIFICATION IS THE TECHNOLOGY BASIS OF BPT EFFLUENT LIMITS				
(A) With Refrigerated Sample Collection				
Minimum	1.32	1.76	1.29	2.09
Maximum	1.64	3.75	1.92	5.49
Average	1.49	2.73	1.51	3.21
(B) With Unrefrigerated Sample Collection				
Minimum	1.45	1.80	1.30	2.59
Maximum	1.62	4.3	1.86	4.01
Average	1.54	3.08	1.53	3.32
(6) MILLS WITH PRIMARY CLARIFICATION; FINAL EFFLUENT LEVELS AT OR BETTER THAN NSPS OPTION 1 LEVELS. PRIMARY CLARIFICATION IS THE TECHNOLOGY BASIS OF BPT EFFLUENT LIMITS				
(A) With Refrigerated Sample Collection				
Minimum	1.32	1.92	1.46	2.85
Maximum	1.64	3.75	1.92	5.49
Average	1.48	3.05	1.64	3.76
(B) With Unrefrigerated Sample Collection				
Minimum	1.62	4.36	1.86	4.01
Maximum	1.62	4.36	1.86	4.01
Average	1.62	4.36	1.86	4.01
(7) MILLS WITH CHEMICALLY ASSISTED CLARIFICATION				
(A) With Refrigerated Sample Collection				
Minimum	2.05	2.56	1.41	2.39
Maximum	2.10	2.83	2.14	2.92
Average	2.08	2.70	1.78	2.66
(B) With Unrefrigerated Sample Collection No Data Available.				

Minimum, maximum, and average variability factors were determined for each of two subsets of mills. These subsets were developed from the group of mills with primary clarification and are as follows:

Subset Number	Subset Description
(5)	Mills with effluent levels at or better than BPT with primary clarification as the technology basis of BPT effluent limits.
(6)	Mills with effluent levels at or better than NSPS Option 1 with primary clarification as the technology basis of BPT effluent limits.

Average maximum daily and maximum 30-day average variability factors for these two subsets are shown in Table VIII-49. Based on the results, where primary clarification is the basis of BPT and NSPS technology options, EPA has based the 30-day average effluent limitations for BOD5 and TSS on the 30-day average variability factors developed for subset (6), using refrigerated data, because (a) subset (6) most resembles treatment system performance that will be required at new sources and (b) refrigeration of samples will be required by permitting authorities.

The resulting BOD5 and TSS 30-day average and daily maximum variability factors to be applied for those technology options where primary clarification is the technology basis are as follows:

30 Day Average Variability Factors

BOD5 = 1.48
TSS = 1.64

Daily Maximum Variability Factors

BOD5 = 3.05
TSS = 3.76

A summary of the variability factors established for conventional pollutant NSPS is presented in Table VIII-50.

TOXIC AND NONCONVENTIONAL POLLUTANT REMOVAL TECHNOLOGY ASSESSMENT

The factors considered in establishing the best available technology economically achievable (BAT) level of control include environmental considerations such as air pollution, energy consumption, and solid waste generation, the costs of applying the control technology, the age of process equipment and facilities, the process employed, process changes, and the engineering aspects of applying various types of control techniques (Section 304(b)(2)(B)). In general, the BAT technology level represents, at a minimum, the best existing

TABLE VIII-50

SUMMARY OF NSPS VARIABILITY FACTORS

BOD5		TSS	
Maximum 30-Day Average	Maximum Day	Maximum 30-Day Average	Maximum Day
1.91	3.54	1.90	3.64

The above variability factors apply for the following subcategories:

Dissolving Kraft
Market Bleached Kraft
BCT Bleached Kraft
Alkaline-Fine
(including Fine Bleached Kraft and Soda)
Unbleached Kraft
Semi-Chemical
Unbleached Kraft and Semi-Chemical
Dissolving Sulfite Pulp
Papergrade Sulfite (Blow Pit and Drum Wash)

Groundwood-Thermo-Mechanical
Groundwood-CMN Papers
Groundwood-Fine Papers

Deink
Tissue From Wastepaper
Paperboard From Wastepaper
Wastepaper-Molded Products
Builders' Paper and Roofing Felt
Nonintegrated-Fine Papers

1.48	3.05	1.64	3.76

The above variability factors apply for the following subcategories:

Nonintegrated-Tissue Papers
Nonintegrated-Lightweight Papers
Nonintegrated-Filter and Nonwoven Papers
Nonintegrated-Paperboard

economically achievable performance of plants of shared characteristics. Where existing performance is uniformly inadequate, BAT technology may be transferred from a different subcategory or industrial category. BAT may include process changes or internal controls, even when not common industry practice.

The primary determinant of BAT is effluent reduction capability using economically achievable technology. As a result of the Clean Water Act of 1977, the achievement of BAT has become the national means of controlling the discharge of toxic pollutants. The best available technology economically achievable must be implemented no later than July 1, 1984, for the control of toxic and nonconventional pollutants.

The Clean Water Act requires that pretreatment standards for existing sources (PSES) and pretreatment standards for new sources (PSNS) control the discharge of pollutants which pass through, interfere with, or are otherwise incompatible with the operation of POTWs. The Act also requires pretreatment for pollutants that limit sludge management alternatives at POTWs, including the beneficial use of sludges on agricultural lands.

In Section VI, EPA recommended that effluent limitations be established for the following three toxic pollutants:

trichlorophenol,
pentachlorophenol, and
zinc.

Another toxic pollutant that could prove to be of concern is chloroform. However, as discussed in Section VI, the Agency determined that promulgation of uniform national BAT limitations and PSES, PSNS, and NSPS controlling the discharge of chloroform is not justified.

The most important nonconventional pollutants associated with the production of pulp, paper, or paperboard are color, ammonia, and resin acids and their derivatives. Uniform national pollutant discharge standards are not being established for these nonconventional pollutants. Color and ammonia may be controlled by permitting authorities on a case-by-case basis as dictated by water quality considerations. Limited information exists on the levels of resin acids and their derivatives present in wastewater discharges from the pulp, paper, and paperboard industry. This sparsity of data makes it impossible at this time to establish uniform national standards limiting the discharge of these compounds.

Control and treatment options have been identified for the control of toxic pollutants (trichlorophenol, pentachlorophenol, zinc, and chloroform) and for the control and treatment of the nonconventional pollutants (ammonia and color), should a case-by-case determination be made that they should be regulated.

Chlorophenolics

Trichlorophenol and pentachlorophenol can be controlled through the substitution of slimicides and biocide formulations that do not contain chlorinated phenolics to replace formulations that contain these toxic pollutants. Substitution would ensure that substantial quantities of the toxic pollutants pentachlorophenol and trichlorophenol would be removed from pulp, paper, and paperboard industry wastewaters.

Chemicals containing pentachlorophenol (PCP) were being used at ten of the 60 facilities sampled during the verification program and at neither of the two mills sampled during the long-term sampling program. Chemicals containing trichlorophenol (TCP) were used at six of the verification mills and neither of the mills sampled in the long-term sampling program. Chlorophenolics were detected and reported at consistently higher levels at facilities where these compounds were used. As a result, chemical substitution is an applicable technology option for control of chlorophenolics. The data used in assessing the capability of chemical substitution were obtained during the verification sampling program, the long-term sampling program, and from industry comments on the January 6, 1981 proposed regulations. These data have been adjusted according to the following formula: Adjusted concentration = (Measured concentration) x (Unit flow basis of BPT effluent limitations)/(Actual mill unit flow). This adjustment was made to reflect the actual mass discharge of TCP and PCP from the sampled mills. This ensures that TCP and PCP data used in assessing the capability of chemical substitution relate the quantity of chlorinated phenolics discharged directly to production.

Data from mills where chlorophenolic-containing biocides are used were not included in assessing the capability of chemical substitution since EPA was interested in determining what reductions occurred when biocides were not used. Only verification and long-term sampling data were used in this assessment because industry data were generated using a different analytical method. Industry data were used to determine if Agency assessments were realistic. Data from the verification and long-term sampling programs were combined and are presented in Tables VIII-51 through VIII-54. The additional TCP and PCP data submitted by industry are summarized in Tables VIII-55 to VIII-58.

EPA learned that chemical substitution does not prevent all discharges of TCP and PCP. TCP is a suspected bleach plant by-product when chlorine or chlorine-containing compounds are used to bleach pulp. PCP, historically used as a biocide in this and other industries, is a known contaminant in wastepaper. In order to differentiate between PCP and TCP present from the use of biocides and the PCP and TCP present from other sources, EPA analyzed the quantity of PCP and TCP present in the wastewaters from mills where chlorine or chlorine-containing compounds are used to bleach pulp and from mills where PCP contamination is likely to occur. EPA then used these quantities to determine what effluent limitations were attainable if the PCP/TCP contribution from biocides were eliminated. (As explained previously, EPA is not setting limits to control PCP and TCP discharges resulting from bleaching or raw material contamination.) Where PCP and TCP were present but not attributable to a particular source, EPA established the effluent limitation at the highest discharge level found. To assess the capability of chemical substitution, the industry was segmented into the following five groupings:

(1) Integrated mills where chlorine or chlorine-containing compounds are used to bleach pulp (at these mills, TCP formation is possible, but PCP contamination is unlikely);

(2) Integrated mills, excluding the semi-chemical subcategory, where chlorine-containing compounds are not used to bleach pulp (at these mills, TCP formation is unlikely and PCP contamination is unlikely);

(3) Deink mills where chlorine or chlorine-containing compounds are used to bleach pulp (at these mills, TCP formation is possible and PCP contamination is likely);

(4) The semi-chemical subcategory and other secondary fiber mills (at these mills, TCP formation is unlikely and PCP contamination is likely); and

(5) Nonintegrated mills (at these mills, TCP formation is unlikely; because some wastepaper is used at a number of these mills, PCP contamination is possible).

As shown in Tables VIII-51 and VIII-52, wastewaters from mills where chlorine or chlorine-containing compounds are used to bleach pulp have higher levels of TCP than wastewaters from other groups of mills. Tables VIII-53 and VIII-54 show that wastewaters from mills where wastepaper is used have higher PCP levels than wastewaters from other groups of mills.

Efforts to characterize the distributional form of the available final effluent data included fitting the normal and lognormal distributions to these data and using several power transformations to make the data symmetric. Results of these analyses showed that it was inappropriate to apply parametric methods (i.e., methods that assume the data follow a particular distributional form) to the data. Therefore, nonparametric methods were used to compute estimated 99th percentiles. In this analysis, data reported as less than minimum reportable concentrations (MRC) were set equal to the MRC.

The 99th percentile (Q_{99}) is defined as the observation numbered closest to .99N. That is,

$$Q_{99} = X\,(\underline{.99N}) \text{ if } .99N \text{ is an integer}$$

$$= X\,(\underline{[.99N]+1}) \text{ if } .99N \text{ is not an integer,}$$

TABLE VIII-51

SUMMARY OF UNCORRECTED TRICHLOROPHENOL RESULTS FOR MILLS WHERE VERIFICATION AND LONG-TERM SAMPLING WERE CONDUCTED AND WHERE CHLOROPHENOLIC BIOCIDES WERE NOT USED

	Influent to Bio-Treatment Concentration (μg/l)(a)			Final Effluent Concentration (μg/l)(a)		
Mill Number	Average	Range	Number of Observations	Average	Range	Number of Observations
MILLS THAT BLEACH PULP USING CHLORINE OR CHLORINE CONTAINING COMPOUNDS						
1. MILLS THAT UTILIZE WASTEPAPER						
140014(b)	47	27-70	3	39	36-42	3
140014(c)				26	8-68	16
140021	8	0-19	19	4	0-25	69
2. MILLS THAT DO NOT UTILIZE WASTEPAPER						
030013	2	0-6	23	3	0-11	69
030020	3	2-4	3	1	0-2	3
030030	19	12-24	3	5	5	3
030047	9	7-10	3	0	0	3
046004	9	9	1	1	1	1
046006	5	4-6	3	4	3-4	3
MILLS THAT DO NOT BLEACH						
1. MILLS THAT UTILIZE WASTEPAPER						
110020	5	3-7	3	0	0	3
110032	1	0-3	3	0	0	3
110043	1	0-2	3	2	0-4	3
2. MILLS THAT DO NOT UTILIZE WASTEPAPER						
Not Detected						

(a) Concentrations are adjusted to BPT flow.

(b) This mill biologically treats only a portion of the total mill effluent. Data shown are representative of the secondary influent and effluent only.

(c) The final effluent data shown are for the total effluent, and are based on an effluent monitoring program conducted by the mill.

TABLE VIII-52
SUMMARY OF UNCORRECTED TRICHLOROPHENOL RESULTS FOR MILLS WHERE VERIFICATION AND LONG-TERM SAMPLING WERE CONDUCTED AND WHERE CHLOROPHENOLIC BIOCIDES WERE USED

Mill Number	Influent to Bio-Treatment Concentration (μg/l)(a) Average	Range	Number of Observations	Final Effluent Concentration (μg/l)(a) Average	Range	Number of Observations
MILLS THAT BLEACH PULP USING CHLORINE OR CHLORINE CONTAINING COMPOUNDS						
1. MILLS THAT UTILIZE WASTEPAPER						
140007	3	0-8	3	4	0-11	3
2. MILLS THAT DO NOT UTILIZE WASTEPAPER						
030004	6	0-10	3	1	0-3	3
030005	1	0-2	3	2	1-2	3
030027	10	7-12	3	4	3-4	3
030032	10	4-17	3	0	0	3
030046	8	6-12	3	2	1-2	3
040013	152	144-161	3	92	74-118	3
040017	6	5-6	3	1	1-2	3
MILLS THAT DO NOT BLEACH						
1. MILLS THAT UTILIZE WASTEPAPER						
110087(b)	278	209-324	3	331	323-346	3
2. MILLS THAT DO NOT UTILIZE WASTEPAPER						
Not Detected						

(a) Concentrations are adjusted to BPT flow.

(b) This mill is a high recycle facility and utilizes primary treatment only. The influent data shown are for the influent to primary. The final effluent data shown are primary effluent data.

TABLE VIII-53
SUMMARY OF UNCORRECTED PENTACHLOROPHENOL RESULTS FOR MILLS WHERE VERIFICATION AND LONG-TERM SAMPLING WERE CONDUCTED AND WHERE CHLOROPHENOLIC BIOCIDES WERE NOT USED

Mill Number	Influent to Bio-Treatment Concentration (μg/1)(a) Average	Range	Number of Observations	Final Effluent Concentration (μg/1)(a) Average	Range	Number of Observations
MILLS THAT BLEACH PULP USING CHLORINE OR CHLORINE CONTAINING COMPOUNDS						
1. MILLS THAT UTILIZE WASTEPAPER						
140014(b)	37	9-55	3	33	29-36	3
140014(c)				16	8-21	16
140021	4	0-11	19		0-22	69
2. MILLS THAT DO NOT UTILIZE WASTEPAPER						
030013	1	0-11	23	1	0-7	69
MILLS THAT DO NOT BLEACH						
1. MILLS THAT UTILIZE WASTEPAPER						
020017	1	0-2	3	0	0-1	3
110020	10	0-16	3	0	0	3
110031	2	0-5	3	0	0	3
110032	2	0-5	3	0	0	3
120050(d)	17	11-25	3	-	-	-
2. MILLS THAT DO NOT UTILIZE WASTEPAPER						
Not Detected						

(a) Concentrations are adjusted to BPT flow.

(b) This mill biologically treats only a portion of the total mill effluent. Data shown are biological influent and effluent only.

(c) This mill biologically treats only a portion of the total mill effluent. The final effluent data shown are for the total effluent, and are based on an effluent monitoring program conducted by the mill.

(d) This mill is a high recycle facility and discharges to a POTW.

TABLE VIII-54
SUMMARY OF UNCORRECTED PENTACHLOROPHENOL RESULTS FOR MILLS WHERE VERIFICATION AND LONG-TERM SAMPLING WERE CONDUCTED AND WHERE CHLOROPHENOLIC BIOCIDES WERE USED

	Influent to Bio-Treatment Concentration (µg/l)(a)			Final Effluent Concentration (µg/l)(a)		
Mill Number	Average	Range	Number of Observations	Average	Range	Number of Observations
MILLS THAT BLEACH PULP USING CHLORINE OR CHLORINE CONTAINING COMPOUNDS						
1. MILLS THAT UTILIZE WASTEPAPER						
140007	8	5-13	3	6	2-10	3
2. MILLS THAT DO NOT UTILIZE WASTEPAPER						
030004	28	7-46	3	28	24-31	3
030046	7	5-10	3	1	0-1	3
040013	0	0-1	3	0	0	3
040017	6	5-6	3	0	0	3
MILLS THAT DO NOT BLEACH						
1. MILLS THAT UTILIZE WASTEPAPER						
015007	2	0-6	3	0	0	3
110087(b)	811	657-927	3	923	846-1076	3
150011	2	0-5	3	1	0-3	3
2. MILLS THAT DO NOT UTILIZE WASTEPAPER						
052004	4	3-8	3	1	0-1	3

(a) Concentrations are adjusted to BPT flow.

(b) This mill is a high recycle facility and utilizes primary treatment only. The influent data shown are for the influent to primary. The final effluent data shown are primary effluent data.

where X(.99N) is the (.99N)th ordered value in a sample of N values ordered from low to high on the random variable X, and [.99N] is the largest integer contained in (.99N). For example, if N = 200, Q_{99} is the 198th ordered daily value, since .99N = 198. If N is 201, .99N = 198.99, so that [.99N] = 198, and Q_{99} = 199. [Computation of percentiles is discussed in several texts. See, for example, R.A. Fisher, *Statistical Methods for Research Workers*, 14th Edition, New York, Hafner Publishing Company (1973)] (209).

Assessment of Trichlorophenol Discharge Characteristics For Mills Where Chlorine or Chlorine-Containing Compounds Are Used to Bleach Pulp. The source of TCP at mills where chlorine or chlorine-containing compounds are used to bleach pulp and where chlorophenolic-containing biocides are not used, is the bleaching process. At these mills, TCP levels are directly related to the quantity of pulp bleached and, therefore, should not be affected by water use. Therefore, discharge levels (on a mass basis) at new mills with lower flows should be equivalent to discharge levels at existing mills. A summary of available data is presented in Table VIII-51. TCP discharge characteristics were assessed using the 99th percentile estimated for each mill from verification and long-term sampling final effluent data. The maximum 99th percentile estimate is 68 µg/l, computed from 16 observations from mill 140014. This value was compared to data submitted by industry representatives and was not exceeded by any other value.

The Agency also assessed TCP discharge characteristics of indirect discharging mills where chlorine or chlorine-containing compounds are used to bleach pulp. EPA determined that some treatment of TCP occurs in biological systems. Data from mill 140014 were used in this analysis. Table VIII-51 presents a summary of these data, which were obtained during the verification and long-term sampling programs. The discharge level for direct dischargers (68 µg/l) was adjusted upward to reflect the level of TCP present after biological treatment [i.e., EPA determined that 17 percent removal of TCP occurred during verification sampling at mill 140014: (47 µg/l - 39 µg/l)/(47 µg/l) = 17 percent]. This results in a discharge level of 82 µg/l for indirect discharging mills where chlorine or chlorine-containing compounds are used to bleach pulp and where chlorophenolic-containing biocides are not used. As discussed previously, TCP levels are directly related to the quantity of pulp bleached and should not be affected by water use. Therefore, discharge levels (on a mass basis) at new mills should be equivalent to discharge levels at existing mills. Data submitted by industry representatives (see Table VIII-55) shows that this level was not exceeded.

Assessment of Pentachlorophenol Discharge Characteristics For Mills Where Wastepaper is Used. The source of PCP at mills where wastepapers are processed and chlorophenolic - containing biocides are not used is raw material contamination. At these mills, PCP levels are directly related to the quantity of wastepaper processed and, therefore, should not be affected by water use. Therefore, discharge levels on a mass basis at new mills with lower flows should be

TABLE VIII-55
SUMMARY OF CORRECTED TRICHLOROPHENOL RESULTS FOR MILLS WHERE CHLOROPHENOLIC BIOCIDES WERE NOT USED
NCASI DATA

Mill Identification	Influent to Bio-Treatment Concentration (μg/l)(a) Average	Range	Number of Observations	Final Effluent Concentration (μg/l)(a) Average	Range	Number of Observations
MILLS THAT BLEACH PULP USING CHLORINE OR CHLORINE CONTAINING COMPOUNDS						
1. MILLS THAT UTILIZE WASTEPAPER						
No Data						
2. MILLS THAT DO NOT UTILIZE WASTEPAPER						
A	12.1	10.5-13.6	2	9.2	7.2-11.7	9
C	13.7	12.1-15.3	2	12.0	10.5-13.6	10
D	21.0	13.9-28.0	2	6.3	1.3-8.3	10
E	11.0	8.4-13.5	2	4.0	2.9-7.4	10
F	14.1	13.2-14.9	2	1.0	0.4-1.9	9
G	9.2	8.3-10.1	2	6.2	5.3-7.5	10
I	10.2	8.6-11.8	2	6.6	1.7-10.6	10
K	66.9	60.5-73.2	2	0.1	0.0-0.7	10
L	12.8	12.8	1	3.7	2.7-5.0	8
M(b)						
N	10.5	10.2-10.8	2	3.3	1.4-5.2	10
O(b)						
P	9.0	7.8-10.1	2	6.5	5.0-8.5	10
Q(b)						
R	14.1	4.0-24.1	2	1.6	0.0-5.3	10
S	23.9	20.6-27.2	2	1.2	0.8-1.9	10
T	3.2	3.1-3.3	2	1.1	0.2-1.9	10
A-100	18.0	12.4-25.4	13	5.5	0.8-25.4	63
B-100	31.5	24.1-37.8	11	23.7	16.4-27.1	36
MILLS THAT DO NOT BLEACH						
1. MILLS THAT UTILIZE WASTEPAPER						
No Data.						
2. MILLS THAT DO NOT UTILIZE WASTEPAPER						
No Data.						

(a) Concentrations are adjusted to BPT flow.

(b) Mill biologically treats only a portion of the total mill effluent. Data were not representative of total mill effluent and were eliminated from the data base.

TABLE VIII-56
SUMMARY OF CORRECTED TRICHLOROPHENOL RESULTS FOR MILLS WHERE CHLOROPHENOLIC BIOCIDES WERE USED
NCASI DATA

	Influent to Bio-Treatment Concentration (µg/l)(a)			Final Effluent Concentration (µg/l)(a)		
Mill Identification	Average	Range	Number of Observations	Average	Range	Number of Observations
MILLS THAT BLEACH PULP USING CHLORINE OR CHLORINE CONTAINING COMPOUNDS						
1. MILLS THAT UTILIZE WASTEPAPER						
No Data						
2. MILLS THAT DO NOT UTILIZE WASTEPAPER						
B	40.0	28.6-51.3	2	23.8	18.9-32.4	10
H	3.7	3.0-4.4	2	2.0	0.7-4.9	10
J	6.9	6.9	1	6.2	3.9-8.8	10
V	11.6	11.2-12.0	2	11.6	8.8-15.6	8
MILLS THAT DO NOT BLEACH						
1. MILLS THAT UTILIZE WASTEPAPER						
No Data						
2. MILLS THAT DO NOT UTILIZE WASTEPAPER						
No Data						

(a) Concentrations are adjusted to BPT flow.

equivalent to discharge levels at existing mills. A summary of the available data is presented in Table VIII-53. As with TCP, PCP discharge characteristics were assessed using the 99th percentile estimated for each mill from verification and long-term sampling final effluent data. The maximum 99th percentile estimate is 22 ug/l, computed from 69 observations from mill 140021. Industry representatives did not submit final effluent data for mills where wastepaper is processed (see Table VIII-57).

Discharge characteristics of indirect discharging mills were also assessed to reflect the treatability of PCP in biological systems. Data from mill 140014 were used in this analysis. Table VIII-53 presents a summary of the data, which were obtained during the verification program. The maximum discharge level for direct dischargers (22 µg/l) was adjusted upward to reflect the level of PCP present after biological treatment [i.e., EPA determined that 11 percent removal of PCP occurred at mill 140014 during verification sampling: (37 µg/l - 33 µg/l)/(37 µg/l) = 11 percent]. This results in a level of 25 µg/l for indirect discharging mills where wastepaper is processed and chlorophenolic-containing biocides are not used. As discussed previously, PCP levels are directly related to the quantity of wastepaper processed and should not be affected by water use. EPA compared this level to data submitted by industry to determine if the Agency assessment is realistic. EPA found that the discharge level of 25 µg/l was exceeded; a maximum value of 31.9 µg/l was reported for mill IV (see Table VIII-57). The Agency then adjusted its evaluation of the maximum discharge level characteristic of indirect discharging mills upward to 32 µg/l.

EPA then reassessed its evaluation of the maximum discharge level characteristic of direct discharging mills. The Agency adjusted the maximum discharge level for indirect discharging mills (32 µg/l) downward to reflect the degree of treatment that occurs through biological treatment. This results in a level of 29 µg/l as the maximum PCP discharge level characteristic of direct discharging mills.

Assessment of Trichlorophenol Discharge Characteristics For Mills Where Chlorine or Chlorine-Containing Compounds Are Not Used. As shown in Table VIII-51, TCP has been measured at only very low levels (all measurements were less than 10 µg/l) at mills where chlorine-containing compounds are not used to bleach pulp and where chlorophenolic-containing biocides are not used. Therefore, the Agency has assumed that 10 µg/l is the maximum TCP discharge level at these mills.

Assessment of Pentachlorophenol Discharge Characteristics For Mills Where Wastepaper is Not Used. As shown in Table VIII-53, PCP has been measured at only very low levels (all measurements were 11 µg/l or less) at mills where chlorophenolic-containing biocides are not used. Therefore, the Agency has assumed that 11 µg/l is the maximum PCP discharge level at these mills.

TABLE VIII-57
SUMMARY OF CORRECTED PENTACHLOROPHENOL RESULTS FOR MILLS WHERE CHLOROPHENOLIC BIOCIDES WERE NOT USED
NCASI DATA

Mill Identification	Influent to Bio-Treatment Concentration (μg/l)(a) Average	Range	Number of Observations	Final Effluent Concentration (μg/l)(a) Average	Range	Number of Observations
MILLS THAT BLEACH PULP USING CHLORINE OR CHLORINE CONTAINING COMPOUNDS						
1. MILLS THAT UTILIZE WASTEPAPER						
No Data						
2. MILLS THAT DO NOT UTILIZE WASTEPAPER						
A	0.7	0.5-0.8	2	0.3	0.0-0.5	9
C	1.6	1.6	2	0.8	0.5-1.7	10
D	1.3	0.9-1.7	2	0.5	0.0-1.1	10
E	2.0	1.9-2.1	2	1.2	0.0-2.0	10
F	1.3	1.3	2	0.9	0.7-1.1	9
G	2.5	2.4-2.6	2	2.7	2.2-3.1	10
I	0.0	0.0	2	0.1	0.0-0.8	10
K	0.8	0.7-0.8	2	0.0	0.0	10
L	3.5	3.5	1	2.1	0.8-2.9	8
M(b)						
N	0.0	0.0	2	0.0	0.0	10
O(b)						
P	0.8	0.7-0.9	2	0.2	0.0-0.9	10
Q(b)						
R	3.0	0.0-5.9	2	0.9	0.0-2.5	10
S	2.0	1.5-2.5	2	0.5	0.0-1.1	10
T	0.4	0.2-0.6	2	0.2	0.1-0.3	10
A-100	0.2	0.0-1.1	13	0.0	0.0	63
B-100	1.2	0.5-1.7	11	0.9	0.0-1.6	36
MILLS THAT DO NOT BLEACH						
1. MILLS THAT UTILIZE WASTEPAPER						
I(c)	6.9	6.1- 7.5	6			
II(c)	7.8	6.1- 9.9	6			
III(c)	7.9	5.6- 9.0	6			
IV(c)	22.4	12.7-31.9	6			
V(c)	9.5	6.4-13.8	6			
VI(c)	18.6	13.9-23.5	6			
VII(c)	15.0	10.4-19.6	6			
VIII(c)	4.2	2.0- 5.5	6			
2. MILLS THAT DO NOT UTILIZE WASTEPAPER						
No Data						

(a) Concentrations are adjusted to BPT flow.

(b) Mill biologically treats only a portion of the total mill effluent. Data were not representative of total mill effluent and were eliminated from the data base.

(c) Data for mills I-VIII are from untreated wastewater samples from mills that manufacture wastepaper board. Most of these mills discharge to POTWs. It is assumed that they do not bleach.

TABLE VIII-58
SUMMARY OF CORRECTED PENTACHLOROPHENOL RESULTS
FOR MILLS WHERE CHLOROPHENOLIC BIOCIDES WERE USED
NCASI DATA

Mill Identification	Influent to Bio-Treatment Concentration (µg/l)(a)			Final Effluent Concentration (µg/l)(a)		
	Average	Range	Number of Observations	Average	Range	Number of Observations
MILLS THAT BLEACH PULP USING CHLORINE OR CHLORINE CONTAINING COMPOUNDS						
1. MILLS THAT UTILIZE WASTEPAPER						
No Data						
2. MILLS THAT DO NOT UTILIZE WASTEPAPER						
B	18.4	1.9-34.9	2	12.5	1.0-23.9	10
H	16.0	6.8-25.1	2	4.9	1.0-13.4	10
J	8.8	8.8	1	11.3	9.0-15.7	10
V	4.1	3.7- 4.5	2	6.4	3.6-10.4	8
MILLS THAT DO NOT BLEACH						
1. MILLS THAT UTILIZE WASTEPAPER						
No Data						
2. MILLS THAT DO NOT UTILIZE WASTEPAPER						
No Data						

(a) Concentrations are adjusted to BPT flow.

Tables VIII-59 and VIII-60 present a summary of the TCP and PCP daily maximum discharge characteristics for each of the five industry groupings.

Zinc

At groundwood mills, zinc hydrosulfite can be used for the bleaching of pulp. Significantly higher quantities of zinc are discharged from mills where zinc hydrosulfite is used than from mills where other bleaching chemicals are used. In 1977, EPA issued BPT regulations controlling the discharge of zinc from groundwood mills based on the application of lime precipitation. The Agency determined that the BPT zinc limitations are now being achieved at all existing direct discharging groundwood mills through chemical substitution (sodium hydrosulfite in place of zinc hydrosulfite). Therefore, the original BPT effluent limitations for zinc ensure that only low levels of zinc are being discharged from direct discharging groundwood mills.

EPA believes that application of zinc limitations and standards based on the same maximum discharge concentration as BPT effluent limitations will have the identical effect as the original BPT regulations: sodium hydrosulfite rather than zinc hydrosulfite will be used to bleach groundwood pulp. This would ensure that only low levels of zinc would be discharged from both direct and indirect discharging mills.

Therefore, for BAT and PSES, zinc limitations and standards were determined as the product of (a) the maximum discharge concentration that forms the basis of BPT effluent limitations for control of zinc and (b) the flows that form the basis of BPT effluent limitations for each of the groundwood subcategories. For NSPS and PSNS, zinc standards were determined as the product of (a) the maximum discharge concentration that forms the basis of BPT effluent limitations for control of zinc and (b) the flows that form the basis of NSPS for each of the groundwood subcategories.

Chloroform

The data used to assess chloroform discharge characteristics were obtained during the verification and long-term sampling programs and from industry comments on the January 6, 1981, proposed regulations.

The Agency's review of available data indicates that there is no correlation between biological effluent and biological influent chloroform. Table VIII-61 presents a summary of the representative data; these data are plotted in Figure VIII-3 and show that chloroform is effectively controlled by BPT technology when BPT effluent limitations are attained, with the exception of mills employing pure oxygen or deep tank activated sludge systems. The fact that mills where volatilization is inhibited discharge higher levels of chloroform suggests that air stripping is the removal mechanism.

TABLE VIII-59

SUMMARY OF PENTACHLOROPHENOL (PCP) AND TRICHLOROPHENOL (TCP) DISCHARGE CHARACTERISTICS FOR DIRECT DISCHARGING MILLS

Mill Category	PCP (μg/l)	TCP (μg/l)
1. Integrated Mills Where Chlorine is Used to Bleach Pulp	11	68
2. Integrated (excluding Semi-Chemical) Mills Where Chlorine is Not Used to Bleach Pulp	11	10
3. Deink (excluding Newsprint) Mills	29	68
4. Other Secondary Fiber and Semi-Chemical Mills	29	10
5. Nonintegrated Mills	29	10

TABLE VIII-60
SUMMARY OF PENTACHLOROPHENOL (PCP) AND TRICHLOROPHENOL (TCP) DISCHARGE CHARACTERISTICS FOR INDIRECT DISCHARGING MILLS

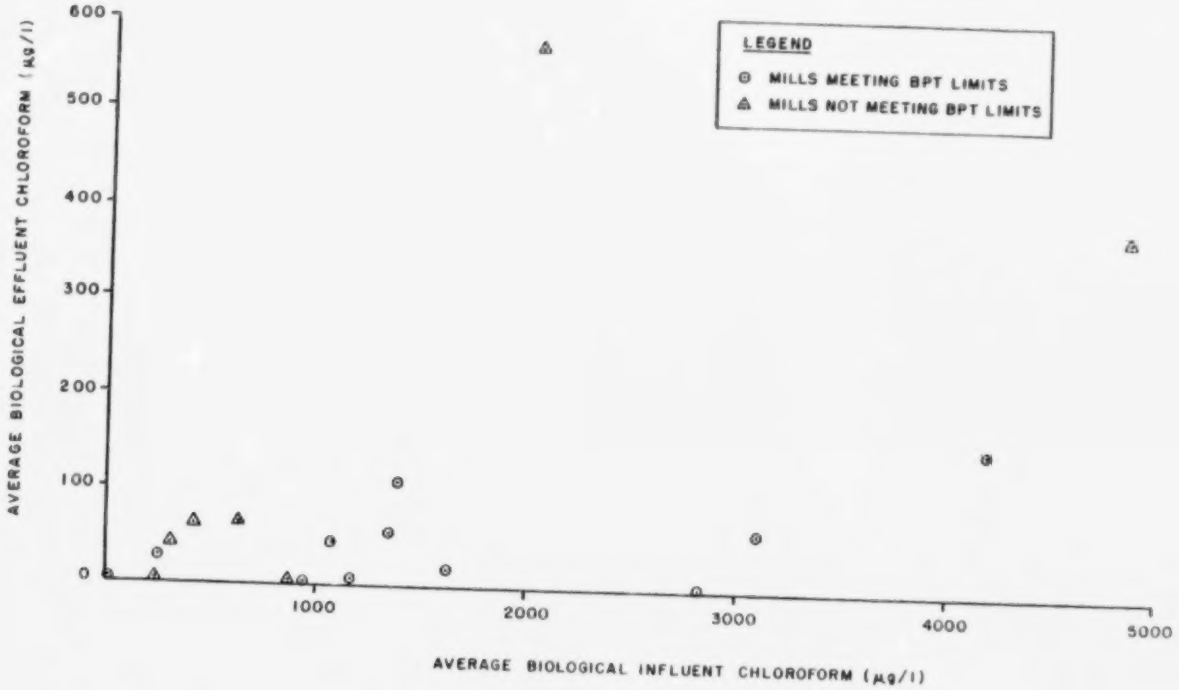
Mill Category	PCP (μg/l)	TCP (μg/l)
1. Integrated Mills Where Chlorine is Used to Bleach Pulp	11	82
2. Integrated (excluding Semi-Chemical) Mills Where Chlorine is Not Used to Bleach Pulp	11	10
3. Deink (excluding Newsprint) Mills	32	82
4. Other Secondary Fiber and Semi-Chemical Mills	32	10
5. Nonintegrated Mills	32	10

TABLE VIII - 61
SUMMARY OF UNCORRECTED CHLOROFORM
BIOLOGICAL INFLUENT AND EFFLUENT CONCENTRATIONS (μg/l)
FROM THE VERIFICATION AND LONG-TERM SAMPLING PROGRAMS
(CHLORINE BLEACHING FACILITIES ONLY)

Subcategory/ Mill Number	Treatment System (a)	Biological Influent			Biological Effluent			Data Source(b)
		Average	Range	Number of Observations	Average	Range	Number of Observations	
FACILITIES MEETING BPT LIMITS								
Market Bleached Kraft								
030005	ASB	1,633	1300-2200	3	17	12-20	3	(V)
030030	ASB	1,177	830-1600	3	7	6-7	3	(V)
BCT Bleached Kraft								
030032	ASB	2,833	1400-4000	3	2	0-4	3	(V)
Alkaline-Fine(c)								
030020	ASB	1,081	43-1700	3	43	39-46	3	(V)
030027	AS	1,400	1100-1800	3	110	110	3	(V)
030046	ASB	963	690-1100	3	4	2-6	3	(V)
Papergrade Sulfite(d)								
040018	AS(c)	3,100	1500-4700	3	56	45-69	3	(V)
Deink-Fine Papers								
140007	AS	4,190	670-9700	3	145	95-240	3	(V)
Deink-Tissue Papers								
140014	AS(e)	1,367	1000-1800	3	55	48-61	3	(V)
140015	AS	25	12-46	3	5	2-10	3	(V)
140021	AS	262	60-800	19	32	10-61	69	(L)
FACILITIES EXCEEDING BPT LIMITS								
Dissolving Kraft								
032001	AS	647	360-900	3	67	40-86	3	(V)
BCT Bleached Kraft								
030004	ASB	877	580-1400	3	6	5-6	3	(V)
Alkaline-Fine(c)								
030013	AS	404	227-772	23	58	21-230	69	(L)
Dissolving Sulfite Pulp								
046004	AS	320	320	1	42	42	1	(V)
046006	ASB	250	110-360	3	3	1-5	3	(V)
Papergrade Sulfite								
040011	AS+TF	2,033	1800-2200	3	573	530-620	3	(V)
040017	DTAS	4,867	1100-8600	3	380	130-600	3	(V)

(a) AS = Activated Sludge System
ASB = Aerated Stabilization Basin
DTAS = Deep Tank Activated Sludge System
TF = Trickling Filter
(b) V = Verification Sampling Program
L = Long-term Sampling Program
(c) Includes Fine Bleached Kraft and Soda subcategories
(d) Includes Papergrade Sulfite (Blow Pit) and Papergrade Sulfite (Drum Wash) subcategories
(e) Only pulp mill waste receives activated sludge treatment; data represents only that waste stream.

FIGURE VIII-3
AVERAGE BIOLOGICAL EFFLUENT CHLOROFORM VERSUS
AVERAGE BIOLOGICAL INFLUENT CHLOROFORM



Data from the verification and long-term sampling programs were combined and are presented in Table VIII-61. The additional chloroform data submitted by industry are summarized in Table VIII-62. Only verification and long-term sampling data were used in this assessment because industry data were generated using a different analytical method. Industry data were used to determine if Agency assessments are realistic.

Efforts to characterize the distributional form of the available final effluent data included fitting the normal and lognormal distributions to available data. Results of these analyses showed that it was inappropriate to apply parametric methods to the data. Therefore, nonparametric methods were used to compute estimated 99th percentiles and resulting maximum day variability factors. These methods have been described in detail earlier in this section.

EPA computed mill-specific maximum day variability factors based on available long-term chloroform data. As shown in Table VIII-63, the average maximum day variability factor for chloroform is 2.94. EPA determined maximum anticipated chloroform discharge levels as the product of (a) the average of the mill-specific maximum day variability factors and (b) the maximum mill-specific long-term average for that group of mills where BPT effluent limits are now being attained. As shown in Table VIII-61, the maximum mill-specific long-term average discharge concentration of chloroform is 145 ug/l. This results in a maximum discharge level of 426 ug/l (2.94 x 145 ug/l = 426 ug/l).

EPA compared this level to data submitted by industry to determine if the Agency assessment is realistic. The Agency found that the discharge level of 426 ug/l was exceeded twice; a maximum value of 450 ug/l was reported for mill 8 and a maximum value of 610 ug/l was reported for mill 13 (see Table VIII-62).

Ammonia

The discharge of ammonia can be controlled at mills where ammonia is used as a base chemical through (a) substitution to a different base chemical or (b) through the application of biological treatment in a mode to allow conversion of ammonia to nitrate. Estimates of the costs associated with ammonia removal technology are presented in Appendix A.

Substitution of a cooking liquor that does not contain ammonia, such as sodium hydroxide, is anticipated to eliminate virtually all ammonia from raw waste discharges. As a result, ammonia may have to be added to the influent to the biological system to ensure effective wastewater treatment. This would result in final effluent discharges of ammonia that are similar to those discharged from all point sources where wastewaters are nutrient deficient.

There are currently no biological treatment systems designed for ammonia removal in use at mills in the pulp, paper, and paperboard

TABLE VIII-62

SUMMARY OF CORRECTED CHLOROFORM EFFLUENT DATA SUBMITTED BY THE NCASI

(μg/1)

Mill Number	Treatment System(a)	Average	Range	Number of Observations
FACILITIES WITH BIO-TREATMENT MEETING BPT LIMITATIONS				
8	AS	388	345-450	4
9	AS	288	235-315	3
11	AS	128	62-175	5
13	ASB	576	520-610	5
FACILITIES WITH BIO-TREATMENT EXCEEDING BPT LIMITATIONS				
1	O_2AS	1018	340-1855	5
2	O_2AS	1261	1040-1415	5
3	O_2AS	1688	1405-2490	9
4	O_2AS	1669	1260-2160	9
5	AS	186	150-210	5
6	AS	232	145-330	5
7	DTAS	1179	915-1350	5
10	AS	81	30-125	5
12	AS	398	360-420	4
14	ASB	160	40-275	5

(a) AS = Activated Sludge System
O_2AS = Pure Oxygen Activated Sludge System
DTAS = Deep Tank Activated Sludge System
ASB = Aerated Stabilization Basin

TABLE VIII-63

MAXIMUM DAY CHLOROFORM VARIABILITY FACTORS COMPUTED USING UNCORRECTED DATA(a)

Mill Number	Number of Observations	Maximum Day Variability Factor	Long-Term Mean (µg/l)	Does Mill Meet BPT Limits?
030013	69	3.97	58	No
140021	69	1.91	32	Yes
Mean Variability Factor		2.94		

(a)Data not adjusted based on BPT flow.

industry. Existing biological treatment systems could be modified to achieve ammonia removal through nitrification. A review of available literature indicates ammonia removal on the order of 90 percent may be achieved through the application of a biological treatment system designed to convert ammonia to nitrate.(100)(117)(121)(122)(123)(124) Table VIII-64 presents predicted final average effluent levels of ammonia based on nitrification technology for the semi-chemical, dissolving sulfite pulp, and both papergrade sulfite subcategories.

Color

As discussed in Section VI, colored effluents may be of concern as dictated by water quality considerations. Color removal technology options have been identified and are discussed below.

In Section VII, four technologies were discussed that are capable of removing color from pulp, paper, and paperboard effluents. These were as follows:

1. Minimum lime coagulation,
2. Alum coagulation,
3. Activated carbon adsorption, and
4. Polymeric resin ion exchange.

These four technologies were evaluated based on the following criteria:

1. Stage of color reduction technology development,
2. Operating problems experienced,
3. Total operating cost,
4. Wastewater streams treated, and
5. Color reduction efficiency.

Based on these five criteria, minimum lime and alum coagulation were identified as the most likely technology options to be used to control color in pulp, paper, and paperboard industry wastewaters. Available color data are presented in Tables V-32 and V-36. For those subcategories where highly-colored effluents are discharged, the ranges of color levels remaining after the application of biological treatment are presented in Table VIII-65.

Anticipated final effluent color levels resulting from the application of lime or alum coagulation are also shown in Table VIII-65. For alum, EPA assumed that the entire effluent would be treated. Based on the studies discussed in Section VII, the Agency determined that an 85 percent reduction in color can be attained through the application of alum coagulation.

EPA assumed that only the more highly-colored process streams, such as the first stage caustic extraction effluent and/or the decker filtrate, would be treated with lime in the dissolving kraft, market bleached kraft, BCT (paperboard, coarse, and tissue) bleached kraft, fine bleached kraft, soda, dissolving sulfite pulp, and both

TABLE VIII-64

PREDICTED RANGE OF AMMONIA FINAL EFFLUENT CONCENTRATIONS

Subcategory	BPT RWL Flow kgal/t	Final Effluent(a) Ammonia	
		lb/t	mg/l
Semi-Chemical	10.3	0.7-3.4	8-39
Dissolving Sulfite Pulp	66.0	1.3-6.3	2-11
Papergrade Sulfite	44.5	1.0-5.0	3-14

(a) As nitrogen.

TABLE VIII-65

SUMMARY OF ANTICIPATED COLOR LEVELS
AFTER MINIMUM LIME/ALUM COAGULATION

Subcategory	Range of Color Levels (Platinum Cobalt Units)	Range of Color Levels Treated by Lime/Alum (Platinum Cobalt Units)	Color Level Reduction (Platinum Cobalt Units)	Range of Anticipated Color Levels in the Final Effluent (Platinum Cobalt Units)
Dissolving Kraft				
w/Lime Coagulation	935-1710	655-1197	524-958	411-752
w/Alum Coagulation	935-1710	935-1710	795-1454	140-257
Market Bleached Kraft				
w/Lime Coagulation	1040-2360	782-1652	582-1322	458-1038
w/Alum Coagulation	1040-2360	1040-2360	884-2006	156-354
BCT Bleached Kraft				
w/Lime Coagulation	1160-2040	812-1428	650-1142	510-898
w/Alum Coagulation	1160-2040	1160-2040	986-1734	174-306
Alkaline-Fine[1]				
w/Lime Coagulation	430-1480	301-1036	241-829	189-651
w/Alum Coagulation	430-1480	430-1480	366-1258	64-222
Unbleached Kraft				
o Linerboard				
w/Lime Coagulation	190-240	190-240	152-192	38-48
w/Alum Coagulation	190-240	190-240	162-204	28-36
o Bag				
w/Lime Coagulation	350-2400	350-2400	280-1920	70-480
w/Alum Coagulation	350-2400	2350-2400	298-2040	52-360
Semi-Chemical				
w/Lime Coagulation	2350-6400	2350-6400	1880-5120	470-1280
w/Alum Coagulation	2350-6400	2350-6400	1998-5440	352-960
Unbleached Kraft and Semi-Chemical				
w/Lime Coagulation	170-390	170-390	136-312	34-78
w/Alum Coagulation	170-390	170-390	145-332	25-58
Dissolving Sulfite Pulp				
w/Lime Coagulation	850-3600	595-2520	476-2016	374-1584
w/Alum Coagulation	850-3600	850-3600	723-3060	127-540
Papergrade Sulfite[2]				
w/Lime Coagulation	<5-3150	<5-2205	<5-1764	<5-1386
w/Alum Coagulation	<5-3150	<5-3150	<5-2678	<5-472

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

papergrade sulfite subcategories. The cost to treat the entire wastewater discharge stream at mills in these subcategories is substantially greater using the lime coagulation process than if only selected streams are treated for color removal. EPA determined that approximately 70 percent of the total color load can be attributed to the first stage caustic extraction effluent and decker filtrate at mills in these eight subcategories.

In determining attainable final effluent color levels, EPA assumed that lime coagulation would be applied to treat the entire effluent at mills in the unbleached kraft, semi-chemical, and unbleached kraft and semi-chemical subcategories. Based on the studies discussed in Section VII, EPA determined that an 80 percent reduction in color can be attained through the application of lime coagulation. This removal is reflected in the anticipated final effluent color levels shown in Table VIII-65.

Costs to achieve these color reductions are presented in Appendix A.

SECTION IX

EFFLUENT REDUCTION ATTAINABLE THROUGH THE APPLICATION OF THE BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE EFFLUENT LIMITATIONS GUIDELINES

GENERAL

The best practicable control technology currently available (BPT) generally is based upon the average of the best existing performance, in terms of treated effluent discharged, by plants of various sizes, ages, and unit processes within an industry or subcategory. Where existing performance is uniformly inadequate, BPT may be transferred from a different subcategory or category. Limitations based on transfer of technology must be supported by a conclusion that the technology is, indeed, transferable and a reasonable prediction that it will be capable of achieving the prescribed effluent limits (see *Tanners' Council of America* v. *Train*, 540 F.2d 1188 (4th Cir. 1976)). BPT focuses on end-of-pipe treatment technology rather than process changes or internal controls except where such changes or controls are common industry practice.

BPT considers the total cost of the application of technology in relation to the effluent reduction benefits to be achieved from the technologies. The cost/benefit inquiry for BPT is a limited balancing, which does not require the Agency to quantify benefits in monetary terms (see, e.g., *American Iron and Steel Institute* v. *EPA*, 526 F.2d 1027 (3rd Cir. 1975)). In balancing costs in relation to effluent reduction benefits, EPA considers the volume and nature of existing discharges, the volume and nature of discharges after application of BPT, the general environmental effects of the pollutants, and the costs and economic impacts of the required pollution control level. The Act does not require or permit consideration of water quality problems attributable to particular point sources or industries, or water quality improvements in particular water bodies (see *Weyerhaeuser Company* v. *Costle*, 5907 F.2d 1101 (D.C. Cir. 1978)).

REGULATED POLLUTANTS

Pollutants regulated under BPT are BOD_5, TSS, and pH.

IDENTIFICATION OF THE BEST PRACTICABLE CONTROL TECHNOLOGY CURRENTLY AVAILABLE

The best practicable control technology currently available for the wastepaper-molded products subcategory was identified as biological treatment. This is the same technology on which BPT limitations are based for all other subcategories of the secondary fibers segment of the pulp, paper, and paperboard industry that are subject to BPT regulations issued in 1974 and 1977 (39 FR 18742 and 42 FR 1398).

EPA also determined that wastewater discharges from the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories are similar in nature to discharges from the nonintegrated-tissue papers subcategory. For these subcategories, the best practicable control technology currently available was identified as primary clarification, which is the technology on which BPT limitations are based for the nonintegrated-tissue papers subcategory.

Biological treatment was identified as the best practicable control technology currently available for the corrugating medium furnish subdivision of the paperboard from wastepaper subcategory and the cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory. Biological treatment is the technology on which BPT limitations are based for all other mills in the paperboard from wastepaper and the nonintegrated-fine papers subcategories that are subject to BPT regulations issued in 1974 and 1977 (39 FR 18742 and 42 FR 1398).

BPT EFFLUENT LIMITATIONS

BPT effluent limitations are presented in Table IX-1.

RATIONALE FOR THE SELECTION OF THE TECHNOLOGY BASIS OF BPT

The Clean Water Act requires the establishment of BCT limitations for industry subcategories from which conventional pollutants are discharged. In order to develop BCT limitations, a base level BPT determination is desirable because the "cost-reasonableness test", required as part of the BCT determination, rests on the incremental cost of removal of BOD_5 and TSS from BPT to BCT.

As discussed in Section IV, four new subcategories of the pulp, paper, and paperboard industry have been identified: wastepaper-molded products, nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard. Additionally, as a result of comments received on the proposed rule, two subcategories were segmented to reflect raw waste load differences resulting from the types of raw material furnish used. EPA established the corrugating medium furnish subdivision of the paperboard from wastepaper subcategory to account for the higher raw waste loads that result from the processing of recycled corrugating medium. The cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory was established to account for the higher raw waste loadings typical of nonintegrated mills where significant quantities of cotton fibers (equal to or greater than four percent of the total product) are used in the production of fine papers.

To provide uniform national BPT effluent limitations for all segments of the pulp, paper, and paperboard industry and to aid in development of BCT limitations, the Agency established BPT effluent limitations for the wastepaper-molded products, nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard

TABLE IX-1

BPT EFFLUENT LIMITATIONS
CONTINUOUS DISCHARGERS
(kg/kkg or lbs/1000 lbs)

Subcategory	Maximum 30-Day Average		Maximum Day	
	BOD5	TSS	BOD5	TSS
Secondary Fibers Segment				
Paperboard From Wastepaper				
o Corrugating Medium Furnish	2.8	4.6	5.7	9.2
Wastepaper-Molded Products	2.3	5.8	4.4	10.8
Nonintegrated Segment				
Nonintegrated Fine Papers				
o Cotton Fiber Furnish	9.1	13.1	17.4	24.3
Nonintegrated-Lightweight Papers				
o Lightweight	13.2	10.6	24.1	21.6
o Electrical	20.9	16.7	38.0	34.2
Nonintegrated-Filter and Nonwoven Papers	16.3	13.0	29.6	26.6
Nonintegrated-Paperboard	3.6	2.8	6.5	5.8

BPT EFFLUENT LIMITATIONS
NONCONTINUOUS DISCHARGERS

Subcategory	Annual Average (kg/kkg or lbs/1000 lbs)		Maximum 30-Day Average (mg/l)		Maximum Day (mg/l)	
	BOD5	TSS	BOD5	TSS	BOD5	TSS
Secondary Fibers Segment						
Paperboard From Wastepaper						
o Corrugating Medium Furnish	1.6	2.1	93	153	189	306
Wastepaper-Molded Products	1.3	3.2	27	66	51	122
Nonintegrated Segment						
Nonintegrated Fine Papers						
o Cotton Fiber Furnish	5.1	7.2	52	74	99	138
Nonintegrated-Lightweight Papers						
o Lightweight	7.4	6.0	65	52	118	106
o Electrical	11.6	9.5	65	52	118	106
Nonintegrated-Filter and Nonwoven Papers	9.1	7.4	65	52	118	106
Nonintegrated-Paperboard	2.0	1.6	65	52	118	106

subcategories. Additionally, EPA amended the existing BPT limitations for the paperboard from wastepaper and the nonintegrated-fine papers subcategories.

METHODOLOGY USED FOR DEVELOPMENT OF BPT EFFLUENT LIMITATIONS

Biological treatment was identified as the best practicable control technology currently available for the wastepaper-molded products subcategory, the corrugating medium furnish subdivision of the paperboard from wastepaper subcategory, and the cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory. The long-term average BPT BOD5 final effluent concentrations for the wastepaper-molded products subcategory and the corrugating medium furnish subdivision of the paperboard from wastepaper subcategory were developed from the equation presented in Section VIII that relates the final effluent BOD5 concentration to the raw waste BOD5 concentration entering a biological treatment system. This relationship is based on biological treatment system performance at those mills used to establish BPT effluent limitations for the major portions of the pulp, paper, and paperboard industry.

The BPT BOD5 effluent limitation promulgated for the nonintegrated-fine papers subcategory in 1977 is much less stringent than BOD5 limitations established for other subcategories with comparable BOD5 raw waste characteristics. Therefore, EPA did not base the long-term average BPT BOD5 final effluent concentration for the cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory on the relationship between BOD5 final effluent concentration and BOD5 raw waste concentration discussed above. Rather, the long-term average BPT BOD5 final effluent concentration for this new subdivision was developed by applying the same percent reduction of BOD5 that forms the basis of BPT effluent limitations for all other mills in the nonintegrated-fine papers subcategory.

As discussed in Section VIII, a relationship was also developed which predicts the anticipated final effluent TSS concentration resulting from biological treatment of wastewaters discharged from pulp, paper, and paperboard mills. This relationship is based on BPT effluent limitations promulgated in 1977 for a major portion of the pulp, paper, and paperboard industry. EPA based the long-term average BPT TSS final effluent concentrations for the wastepaper-molded products subcategory, the corrugating medium furnish subdivision of the paperboard from wastepaper, and the cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory on this relationship.

Long-term average BOD5 and TSS final effluent mass loads were calculated by multiplying attainable final effluent concentrations by the effluent flow rates characteristic of each subcategory/subdivision.

In making the decision to base BPT effluent limitations for the new subcategory and the two new subdivisions mentioned above on biological treatment, the Agency determined that biological treatment is available and is now employed at many mills in the wastepaper-molded products subcategory, the corrugating medium furnish subdivision of the paperboard from wastepaper subcategory, and the cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory. For the wastepaper-molded products subcategory and the corrugating medium furnish subdivision of the paperboard from wastepaper subcategory, BPT limitations are based on the ability of biological systems to treat the same pollutants (BOD5 and TSS) to levels representative of BPT effluent limitations established for other subcategories with comparable BOD5 raw waste characteristics. For the cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory, BPT limitations are based on the ability of biological treatment to remove the same pollutants (BOD5 and TSS) to the same degree as occurs at all other mills in the nonintegrated-fine papers subcategory.

When applied at mills in the wastepaper-molded subcategory, the corrugating medium furnish subdivision of the paperboard from wastepaper subcategory, and the cotton-fiber furnish subdivision of the nonintegrated-fine papers subcategory, biological treatment is capable of attaining the BPT effluent limitations presented in Table IX-1.

Primary treatment was identified as the best practicable control technology currently available for the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories. The wastewater characteristics of these three nonintegrated subcategories are similiar in nature to those of the nonintegrated-tissue papers subcategory. Long-term average BPT final effluent BOD5 and TSS concentrations were transferred from the nonintegrated-tissue papers subcategory to the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories. Long-term average final effluent loads were calculated by multiplying attainable final effluent concentrations by the effluent flow rates characteristic of these subcategories.

The Agency determined that primary treatment is available and could be employed at mills in the three new nonintegrated subcategories. Raw waste characteristics at mills in the nonintegrated-filter and nonwoven papers, nonintegrated-lightweight papers, and nonintegrated-paperboard subcategories are comparable to those at mills in the nonintegrated-tissue papers subcategory. The BPT limitations are based on the ability of primary clarification to treat the same pollutants (BOD5 and TSS) to the same levels as now occurs at mills in the nonintegrated-tissue papers subcategory. When applied at mills in the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and the nonintegrated-paperboard subcategories, primary treatment is capable of attaining the BPT effluent limitations presented in IX-1.

BPT maximum 30-day and maximum day effluent limitations were determined by multiplying long-term average effluent limitations by appropriate variability factors developed in the 1974 and 1977 BPT rulemaking (see Table IX-2).

COST OF APPLICATION AND EFFLUENT REDUCTION BENEFITS

EPA anticipates that only one of the six subcategories for which new or revised BPT limitations were established will incur compliance costs. Four mills in the wastepaper-molded products subcategory are expected to invest a total of $6.01 million and incur total annual costs of $1.84 million (1978 dollars).

Upon compliance with BPT effluent limitations for the four new subcategories, the Agency estimates that conventional pollutant removals from industry raw waste discharges will be 3.5 million kg/yr (7.7 million lbs/yr) of $BOD\underline{5}$ and 13.5 million kg/yr (29.8 million lbs/yr) of TSS. These represent removals of 66 percent $BOD\underline{5}$ and 89 percent TSS from the raw waste levels of these pollutants for the four new subcategories.

EPA does not anticipate any additional pollutant removals from the corrugating medium furnish subdivision of the paperboard from wastepaper subcategory as a result of this rulemaking since the amended BPT effluent limitations are less stringent than the BPT effluent limitations established in 1974 for the entire paperboard from wastepaper subcategory. BPT limitations were relaxed for this new subcategory subdivision to account for an increase in $BOD\underline{5}$ raw waste loads since the implementation of BPT in 1977.

Existing permits for the two direct discharging mills in the cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory are more stringent than the final BPT effluent limitations for this new subcategory subdivision; therefore, EPA anticipates no additional removal of conventional pollutants as a result of this regulation. (Compliance with final BPT effluent limitations would mean that conventional pollutant removals from raw waste discharges from the two direct discharging mills in the cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory would be 165,200 kg/yr (363,400 lbs/yr) of $BOD\underline{5}$ and 691,400 kg/yr (1.5 million lbs/yr) of TSS. These represent removals of 53 percent $BOD\underline{5}$ and 77 percent TSS from the raw waste levels of these pollutants for this subdivision.)

NON-WATER QUALITY ENVIRONMENTAL IMPACTS

Sections 304(b) and 306 of the Act require EPA to consider the non-water quality environmental impacts (including air pollution, solid waste generation, and energy requirements) of certain regulations. In conformance with these provisions, EPA considered the effect of this regulation on air pollution, solid waste generation, and energy consumption. The BPT regulation was reviewed by EPA personnel responsible for non-water quality related programs. While it is difficult to balance pollution problems against each other and against energy use, EPA believes this regulation will best serve often competing national goals. The Administrator determined that the

TABLE IX-2

VARIABILITY FACTORS USED IN THE DEVELOPMENT OF BPT EFFLUENT LIMITATIONS[1]

Subcategory	Maximum 30-Day Average		Maximum Day	
	BOD$_5$	TSS	BOD$_5$	TSS
Secondary Fibers Segment				
Paperboard From Wastepaper o Corrugating Medium Furnish	1.77	2.18	3.54	4.36
Wastepaper-Molded Products	1.78	1.82	3.42	3.38
Nonintegrated Segment				
Nonintegrated-Fine Papers o Cotton Fiber Furnish	1.78	1.82	3.42	3.38
Nonintegrated-Lightweight Papers	1.79	1.76	3.25	3.60
Nonintegrated-Filter and Nonwoven Papers	1.79	1.76	3.25	3.60
Nonintegrated-Paperboard	1.79	1.76	3.25	3.60

---

[1] These variability factors were developed in the BPT rulemaking.(46)(48) Variability factors for the Nonintegrated-Lightweight Papers, Nonintegrated-Filter and Nonwoven Papers, and Nonintegrated-Paperboard subcategories are based on the variability factors originally developed for the Nonintegrated-Tissue Papers subcategory because BPT is based on primary treatment for each of these nonintegrated subcategories. Variability factors for the Cotton Fiber Furnish subdivision of the Nonintegrated-Fine Papers subcategory and the Wastepaper-Molded Products subcategory are based on variability factors applicable to those Phase II subcategories where BPT was based on biological treatment. Variability factors originally developed for the Paperboard From Wastepaper subcategory were applied to the Corrugating Medium Furnish subdivision of the Paperboard From Wastepaper subcategory.

non-water quality impacts identified below are justified by the benefits associated with compliance with the regulation.

Energy

EPA estimates that attainment of BPT will require the use of the equivalent of 604 thousand liters (3800 barrels) per year of residual fuel oil, an increase of 0.0017 percent of current industry energy usage.

Solid Waste

EPA estimates that attainment of BPT will result in an additional 100 kkg (110 tons) per year of wastewater treatment solids. This is equal to 0.0042 percent of current wastewater solids generated in the industry.

Air and Noise

Attainment of BPT will have no measurable impact on air or noise pollution.

SECTION X

EFFLUENT REDUCTION ATTAINABLE THROUGH THE APPLICATION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE EFFLUENT LIMITATIONS GUIDELINES

GENERAL

As a result of the Clean Water Act of 1977, the achievement of BAT has become the principal national means of controlling wastewater discharges of toxic pollutants. The factors considered in establishing the best available technology economically achievable (BAT) level of control include the costs of applying the control technology, the age of process equipment and facilities, the process employed, process changes, the engineering aspects of applying various types of control technologies, and non-water quality environmental considerations such as energy consumption, solid waste generation, and air pollution (Section 304(b)(2)(B)). In general, the BAT technology level represents, at a minimum, the best economically-achievable performance of plants of shared characteristics. Where existing performance is uniformly inadequate, BAT technology may be transferred from a different subcategory or industrial category. BAT may include process changes or internal controls, even when not common industry practice.

The statutory assessment of BAT "considers" costs, but does not require a balancing of costs against effluent reduction benefits (see Weyerhaeuser v. Costle, 590 F.2d 1011 (D.C. Cir. 1978)). In assessing BAT, EPA has given substantial weight to the reasonableness of costs. The Agency has considered the volume and the nature of discharges, the volume and nature of discharges expected after application of BAT, the general environmental effects of the pollutants, and the costs and economic impacts of the required pollution control levels. Despite this expanded consideration of costs, the primary determinant of BAT is effluent reduction capability using economically achievable technology.

REGULATED POLLUTANTS

Toxic Pollutants

The Agency decided to regulate three different toxic pollutants present in wastewater discharges from mills in the pulp, paper, and paperboard industry: zinc, trichlorophenol (TCP), and pentachlorophenol (PCP). BAT effluent limitations were established in all subcategories for TCP and PCP. Zinc is regulated in the groundwood-thermo-mechanical, groundwood-CMN papers, and groundwood-fine papers subcategories.

IDENTIFICATION OF THE BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

The Agency selected substitution of chemicals as the basis for control of trichlorophenol and pentachlorophenol. Fungicides and slimicides containing trichlorophenol and pentachlorophenol can be replaced by formulations that do not contain these toxic pollutants.

In the groundwood subcategories, the BAT limitations for zinc are identical to BPT limitations for control of this toxic metal. The technology basis for BPT limitations is lime precipitation; however, EPA found that mills in the groundwood subcategories have complied with the BPT effluent limitations through the substitution of sodium hydrosulfite, a bleaching chemical, for zinc hydrosulfite.

BAT EFFLUENT LIMITATIONS

BAT effluent limitations are presented in Table X-1.

RATIONALE FOR THE SELECTION OF THE TECHNOLOGY BASIS OF BAT

An evaluation of verification data indicated that pentachlorophenol and trichlorophenol are not effectively removed through the application of primary or biological treatment, the technology bases of BPT effluent limitations for all subcategories. EPA selected substitution of fungicides and slimicides not containing trichlorophenol or pentachlorophenol as the basis for BAT limitations because chemical substitution greatly reduces the discharge of these toxic pollutants. Total removal is not achieved because some wastepapers are contaminated with low levels of PCP and because low levels of TCP are formed when pulp is bleached with chlorine or chlorine-containing compounds. EPA estimates that alternative chemicals are currently being used at approximately 80 percent of the mills in the pulp, paper, and paperboard industry, supporting the Agency's decision to base effluent limitations on chemical substitution. A survey of chemical suppliers shows that no measurable increase in production costs can be expected as a result of using biocides that do not contain chlorophenolics.

The presence of significant quantities of zinc in groundwood mill effluents at the time of development of BPT limitations was due to the use of zinc hydrosulfite, a bleaching chemical. After promulgation of BPT effluent limitations guidelines, the discharge of zinc from pulp, paper, and paperboard mills was substantially reduced to levels below treatability through the substitution of sodium hydrosulfite for zinc hydrosulfite. Regulation of zinc at BPT levels was, therefore, selected as the basis of BAT effluent limitations.

In commenting on proposed BAT effluent limitations, some commenters stated that tertiary treatment (i.e., chemically assisted clarification or CAC) should form the technology basis of the BAT effluent limitations for the toxic pollutants pentachlorophenol (PCP), trichlorophenol (TCP), and zinc. Chemically assisted clarification

TABLE X-1

BAT EFFLUENT LIMITATIONS
(kg/kkg or lbs/1000 lbs)

Subcategory	Maximum Day		
	PCP[1]	TCP[2]	Zinc
Integrated Segment			
Dissolving Kraft	0.0025	0.016	NA
Market Bleached Kraft	0.0019	0.012	NA
BCT Bleached Kraft	0.0016	0.010	NA
Alkaline-Fine[3]	0.0014	0.0088	NA
Unbleached Kraft			
o Linerboard	0.00058	0.00053	NA
o Bag	0.00058	0.00053	NA
Semi-Chemical	0.0012	0.00043	NA
Unbleached Kraft and Semi-Chemical	0.00064	0.00059	NA
Dissolving Sulfite Pulp			
o Nitration	0.0030	0.019	NA
o Viscose	0.0030	0.019	NA
o Cellophane	0.0030	0.019	NA
o Acetate	0.0033	0.021	NA
Papergrade Sulfite[4]	*	*	*
Groundwood-Thermo-Mechanical	0.00097	0.00088	0.26
Groundwood-CMN Papers	0.0011	0.00099	0.30
Groundwood-Fine Papers	0.0010	0.00092	0.27
Secondary Fibers Segment			
Deink			
o Fine Papers	0.0030	0.0069	NA
o Tissue Papers	0.0030	0.0069	NA
o Newsprint	0.0030	0.0010	NA
Tissue From Wastepaper	0.0030	0.0011	NA
Paperboard From Wastepaper			
o Corrugating Medium Furnish	0.00087	0.00030	NA
o Noncorrugating Medium Furnish	0.00087	0.00030	NA
Wastepaper-Molded Products	0.0026	0.00088	NA
Builders' Paper and Roofing Felt	0.0017	0.00060	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	0.0018	0.00064	NA
o Cotton Fiber Furnish	0.0051	0.0018	NA
Nonintegrated-Tissue Papers	0.0028	0.00096	NA
Nonintegrated-Lightweight Papers			
o Lightweight	0.0059	0.0020	NA
o Electrical	0.0093	0.0032	NA
Nonintegrated-Filter and Nonwoven Papers	0.0072	0.0025	NA
Nonintegrated-Paperboard	0.0016	0.00054	NA

*Papergrade Sulfite Equations:

PCP = 0.00058 exp(0.017x)
TCP = 0.0036 exp(0.017x)
Where x equals percent sulfite pulp produced on-site in the final product.

[1] PCP = Pentachlorophenol

[2] TCP = Trichlorophenol

[3] Includes Fine Bleached Kraft and Soda subcategories.

[4] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

NA = Not applicable.

TABLE X-1 (continued)

BAT EFFLUENT LIMITATIONS
NONCONTINUOUS DISCHARGERS

(concentrations mg/l)

Subcategory	Maximum Day		
	PCP[1]	TCP[2]	Zinc
Integrated Segment			
Dissolving Kraft	(0.011)(55.1)/Y	(0.068)(55.1)/Y	NA
Market Bleached Kraft	(0.011)(41.6)/Y	(0.068)(41.6)/Y	NA
BCT Bleached Kraft	(0.011)(35.4)/Y	(0.068)(35.4)/Y	NA
Alkaline-Fine[3]	(0.011)(30.9)/Y	(0.068)(30.9)/Y	NA
Unbleached Kraft			
o Linerboard	(0.011)(12.6)/Y	(0.010)(12.6)/Y	NA
o Bag	(0.011)(12.6)/Y	(0.010)(12.6)/Y	NA
Semi-Chemical	(0.029)(10.3)/Y	(0.010)(10.3)/Y	NA
Unbleached Kraft and Semi-Chemical	(0.011)(14.0)/Y	(0.010)(14.0)/Y	NA
Dissolving Sulfite Pulp			
o Nitration	(0.011)(66.0)/Y	(0.068)(66.0)/Y	NA
o Viscose	(0.011)(66.0)/Y	(0.068)(66.0)/Y	NA
o Cellophane	(0.011)(66.0)/Y	(0.068)(66.0)/Y	NA
o Acetate	(0.011)(72.7)/Y	(0.068)(72.7)/Y	NA
Papergrade Sulfite[4]	*	*	
Groundwood-Thermo-Mechanical	(0.011)(21.1)/Y	(0.010)(21.1)/Y	(3.0)(21.1)/Y
Groundwood-CMN Papers	(0.011)(23.8)/Y	(0.010)(23.8)/Y	(3.0)(23.8)/Y
Groundwood-Fine Papers	(0.011)(21.9)/Y	(0.010)(21.9)/Y	(3.0)(21.9)/Y
Secondary Fibers Segment			
Deink			
o Fine Papers	(0.029)(24.4)/Y	(0.068)(24.4)/Y	NA
o Tissue Papers	(0.029)(24.4)/Y	(0.068)(24.4)/Y	NA
o Newsprint	(0.029)(24.4)/Y	(0.010)(24.4)/Y	NA
Tissue From Wastepaper	(0.029)(25.2)/Y	(0.010)(25.2)/Y	NA
Paperboard From Wastepaper			
o Corrugating Medium Furnish	(0.029)(7.2)/Y	(0.010)(7.2)/Y	NA
o Noncorrugating Medium Furnish	(0.029)(7.2)/Y	(0.010)(7.2)/Y	NA
Wastepaper-Molded Products	(0.029)(21.1)/Y	(0.010)(21.1)/Y	NA
Builders' Paper and Roofing Felt	(0.029)(14.4)/Y	(0.010)(14.4)/Y	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	(0.029)(15.2)/Y	(0.010)(15.2)/Y	NA
o Cotton Fiber Furnish	(0.029)(42.3)/Y	(0.010)(42.3)/Y	NA
Nonintegrated-Tissue Papers	(0.029)(22.9)/Y	(0.010)(22.9)/Y	NA
Nonintegrated-Lightweight Papers			
o Lightweight	(0.029)(48.7)/Y	(0.010)(48.7)/Y	NA
o Electrical	(0.029)(76.9)/Y	(0.010)(76.9)/Y	NA
Nonintegrated-Filter and Nonwoven Papers	(0.029)(59.9)/Y	(0.010)(59.9)/Y	NA
Nonintegrated-Paperboard	(0.029)(12.9)/Y	(0.010)(12.9)/Y	NA

Y = Mill wastewater discharged per ton of product.
NA = Not Applicable.

*Papergrade Sulfite Equations:

PCP = ((0.011)(12.67) exp(0.017x))/Y
TCP = ((0.068)(12.67) exp(0.017x))/Y
Where x equals percent sulfite pulp produced on-site in the final product.

[1] PCP = Pentachlorophenol

[2] TCP = Trichlorophenol

[3] Includes Fine Bleached Kraft and Soda subcategories.

[4] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

(CAC) is an end-of-pipe treatment technology primarily employed to achieve a further reduction in suspended solids beyond the levels attained through the application of biological or primary treatment only. No data were submitted with comments, nor was the Agency aware of any data, that would allow the EPA to establish a relationship between removal of suspended solids and removal of the three toxic pollutants (PCP, TCP, and zinc). Therefore, the Agency was unable to establish regulations for control of PCP, TCP, and zinc based on CAC. Further, based on available data, the Agency determined that PCP, TCP, and zinc can be effectively controlled through chemical substitution. As discussed later in this section, limitations based on chemical substitution will lead to significant removals of regulated toxics. Thus, EPA based final regulations controlling PCP, TCP, and zinc on chemical substitution.

METHODOLOGY USED FOR DEVELOPMENT OF BAT EFFLUENT LIMITATIONS

Zinc

BAT limitations for zinc are identical to BPT limitations for control of this toxic metal. Limitations are based on the maximum anticipated discharge concentration of zinc after the application of lime precipitation. As explained previously, the Agency expects that these limitations will be attained through substitution of sodium hydrosulfite for zinc hydrosulfite in bleaching groundwood pulp.

Trichlorophenol

The Agency assessed TCP discharge characteristics at mills in the pulp, paper, and paperboard industry taking into account whether chlorophenolic-containing biocides were used in the manufacturing process. EPA found that TCP discharges were significantly lower at those mills where chlorophenolic-containing biocides were not used. To determine the discharge levels of TCP that result from substitution of chlorophenolic-containing biocides, the Agency assessed all available data for mills where chlorophenolic-containing biocides were not employed.

EPA found that higher levels of TCP were discharged from mills where chlorine-containing compounds were used to bleach pulp than from other mills. This is because low levels of TCP are formed in the bleaching process at mills where chlorine-containing compounds are used to bleach pulp. EPA determined the maximum discharge levels of TCP for mills where chlorine-containing compounds were used in the bleaching process and for mills where no chlorine-containing compounds were used. Based on all available data, the maximum discharge concentration of trichlorophenol at direct discharging mills where chlorophenolic-containing biocides are not used and chlorine-containing compounds are used to bleach pulp was determined to be 68 ug/l. The maximum discharge concentration of trichlorophenol at direct discharging mills where chlorophenolic-containing biocides were not used and where chlorine-containing compounds were not used to bleach pulp was determined to be 10 ug/l.

Pentachlorophenol

The Agency assessed PCP discharge characteristics at mills in the pulp, paper, and paperboard industry taking into account whether chlorophenolic-containing biocides were used in the manufacturing process. EPA found that PCP discharges were significantly lower at those mills where chlorophenolic-containing biocides were not used. To determine the discharge levels of PCP that result from substitution of chlorophenolic-containing biocides, the Agency assessed all available data for mills where chlorophenolic-containing biocides were not employed.

EPA found that higher levels of PCP were discharged from mills where wastepapers were processed than from other mills. This is caused by low level PCP contamination of wastepaper. EPA determined the maximum discharge levels of PCP for mills where wastepaper was processed and for mills where wastepaper was not processed. Based on all available data, the maximum discharge concentration of pentachlorophenol at direct discharging mills where chlorophenolic-containing biocides were not used and where wastepaper was processed was determined to be 29 ug/l. The maximum discharge concentration of pentachlorophenol at direct discharging mills where chlorophenolic-containing biocides were not used and where wastepaper was not processed was determined to be 11 ug/l.

Mass limitations for each subcategory in kg/kkg (lbs/1000 lbs) were calculated as the product of the anticipated maximum day TCP and PCP effuent concentrations and the flows that form the basis of BPT for each subcategory.

A more detailed discussion of the development of BAT effluent limitations is presented in Section VIII.

COST OF APPLICATION AND EFFLUENT REDUCTION BENEFITS

Fungicide and Slimicide Substitution

Other than costs associated with monitoring for TCP and PCP, EPA estimates that there is no cost associated with this technology; substitute chemicals are available at comparable costs. Since the final BAT regulation does not require monitoring where facilities certify that substitute chemicals are being used to control PCP and TCP, EPA anticipates that monitoring will rarely be required.

EPA estimates that the total mass of regulated pollutants removed from industry wastewaters that are discharged directly to navigable waters will be about 13,700 kg/yr (30,200 lb/yr) of trichlorophenol and 9,590 kg/yr (21,100 lb/yr) of pentachlorophenol.

Zinc Removal

There is no cost or pollutant removal associated with this technology. BAT limitations are equivalent to existing BPT limitations.

NON-WATER QUALITY ENVIRONMENTAL IMPACTS

Sections 304(b) and 306 of the Act require EPA to consider the non-water quality environmental impacts (including air pollution, solid waste generation, and energy requirements) of certain regulations. In conformance with these provisions, the Agency considered the effect of this regulation on air pollution, solid waste generation, and energy consumption. EPA anticipates that attainment of these limitations will result in no increased energy usage nor will it contribute to air pollution, noise generation, or solid waste generation.

SECTION XI

EFFLUENT REDUCTION ATTAINABLE THROUGH THE APPLICATION OF BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY EFFLUENT LIMITATIONS GUIDELINES

GENERAL

The 1977 amendments added section 301(b)(2)(E) to the Act, establishing "best conventional pollutant control technology" (BCT) for discharges of conventional pollutants from existing industrial point sources. Conventional pollutants are those defined in section 304(a)(4) (biological oxygen demanding pollutants (BOD_5), total suspended solids (TSS), fecal coliform, and pH), and any additional pollutants defined by the Administrator as "conventional" (oil and grease; 44 FR 44501, July 30, 1979).

BCT is not an additional limitation but replaces BAT for the control of conventional pollutants. In addition to other factors specified in section 304(b)(4)(B), the Act requires that BCT limitations be assessed in light of a two part "cost-reasonableness" test. American Paper Institute v. EPA, 660 F.2d 954 (4th Cir. 1981). The first test compares the cost for private industry to reduce its conventional pollutants with the costs to publicly owned treatment works (POTWs) for similar levels of reduction in their discharge of these pollutants. The second test examines the cost-effectiveness of additional industrial treatment beyond BPT. EPA must find that limitations are "reasonable" under both tests before establishing them as BCT. In no case may BCT be less stringent than BPT.

EPA published its methodology for carrying out the BCT analysis on August 29, 1979 (44 FR 50732). BPT and BAT limitations, NSPS, PSES, and PSNS were proposed for the pulp, paper, and paperboard industry on January 6, 1981 (46 FR 1430). At that time, BCT effluent limitations were also proposed. However, EPA was later ordered by the Court of Appeals for the Fourth Circuit to correct data and methodological errors in its BCT cost test and to develop a new BCT methodology (see American Paper Institute v. EPA, 660 F.2d 954 (4th Cir. 1981)). Revised BCT limitations were recently reproposed along with the new BCT methodology (see 47 FR 49176, October 29, 1982).

This document does not address BCT limitations. (For a discussion of control and treatment options known to be capable of reducing the discharge of conventional pollutants in pulp, paper, and paperboard industry wastewaters, see the January 1981 proposal and Development Document for Proposed Effluent Limitations Guidelines and Standards for the Pulp, Paper, and Paperboard and the Builders' Paper and Board Mills Point Source Categories (U.S. EPA, December, 1980).)

SECTION XII

NEW SOURCE PERFORMANCE STANDARDS

GENERAL

The basis for new source performance standards (NSPS) under section 306 of the Act is the best available demonstrated technology. At new plants, the opportunity exists to design the best and most efficient production processes and wastewater treatment facilities. Therefore, Congress directed EPA to consider the best demonstrated process changes, in-plant controls, and end-of-pipe treatment technologies that reduce pollution to the maximum extent feasible. It is encouraged that at new sources, reductions in the use of and/or discharge of both water and wastewater pollutants be attained by application of in-plant control measures.

REGULATED POLLUTANTS

Conventional Pollutants

Conventional pollutants regulated under NSPS are: BOD_5, TSS, and pH.

Toxic Pollutants

Toxic pollutants controlled under NSPS, as for BAT, are pentachlorophenol (PCP), trichlorophenol (TCP), and zinc.

Nonconventional Pollutants

No nonconventional pollutants are regulated under NSPS.

IDENTIFICATION OF THE TECHNOLOGY BASIS OF NSPS

Conventional Pollutant Control

The technology basis for control of conventional pollutants under NSPS is a combination of commonly employed production process controls and end-of-pipe treatment of the type that forms the basis of BPT effluent limitations (either primary or biological treatment).

Toxic Pollutant Control

The technology basis of final NSPS for zinc, trichlorophenol, and pentachlorophenol is substitution of chemicals. Fungicide and slimicide formulations containing trichlorophenol and pentachlorophenol can be replaced with formulations that do not contain these toxic pollutants. Zinc hydrosulfite, a chemical used to bleach groundwood pulps, can be replaced with sodium hydrosulfite.

NEW SOURCE PERFORMANCE STANDARDS

New source performance standards for conventional pollutants are presented in Tables XII-1 and XII-2. New source performance standards for toxic pollutants are presented in Table XII-3.

RATIONALE FOR THE SELECTION OF THE TECHNOLOGY BASIS FOR NSPS

Conventional Pollutant Control Technology

Final NSPS, like proposed NSPS, are based on commonly employed production process controls and end-of-pipe treatment of the type that forms the basis of BPT effluent limitations (either primary or biological treatment). However, the Agency has modified the methodology used at proposal to determine the conventional pollutant final effluent loadings that result from application of these technologies.

In establishing final NSPS, EPA considered a broader set of mills in determining the raw waste flow and BOD_5 reductions that will result from application of in-plant production process controls. The raw waste flows that form the basis of final NSPS have been demonstrated at mills in every subcategory of the pulp, paper, and paperboard industry. The BOD_5 raw waste loads that form the basis of final NSPS have been demonstrated in 23 of 24 subcategories. The Agency also adjusted its method of calculating attainable effluent concentrations of BOD_5 and TSS to account for those situations where BOD_5 raw waste concentrations increase after the application of in-plant production process controls. These modifications resulted in final NSPS that are less stringent than if the proposed methodology were used. (This revised methodology is discussed in detail in Section VIII of this document.)

The end-of-pipe treatment systems that form the basis of final NSPS are the same as those commonly employed to comply with BPT effluent limitations but are considerably larger, especially in the integrated segment. Therefore, they are more efficient in controlling conventional pollutants. (For example, the detention time for activated sludge treatment is 12 rather than 8 hours). These larger systems are now employed at mills in many subcategories of this industry. Although these larger systems are not employed at mills in all subcategories, the technology is readily available. The Agency determined that these systems can be designed, constructed, and operated at new sources in every subcategory of the pulp, paper, and paperboard industry and, in combination with commonly employed production process controls, are capable of meeting the final NSPS.

The combination of reduced raw waste loads (attainable through the application of commonly employed in-plant production process controls) and more efficient end-of-pipe treatment systems (that can be designed and employed in this industry) form the basis of NSPS. This combination of technologies results in conventional pollutant limitations that have not been achieved at existing mills in every

TABLE XII-1

NEW SOURCE PERFORMANCE STANDARDS
CONVENTIONAL POLLUTANTS
(kg/kkg or lbs/1000 lbs)

Subcategory	Maximum 30-Day Average		Maximum Day	
	BOD5	TSS	BOD5	TSS
Integrated Segment				
Dissolving Kraft	8.4	14.3	15.6	27.3
Market Bleached Kraft	5.5	9.5	10.3	18.2
BCT Bleached Kraft	4.6	7.6	8.5	14.6
Alkaline-Fine[1]	3.1	4.8	5.7	9.1
Unbleached Kraft				
o Linerboard	1.8	3.0	3.4	5.8
o Bag	2.7	4.8	5.0	9.1
Semi-Chemical	1.6	3.0	3.0	5.8
Unbleached Kraft and Semi-Chemical	2.1	3.8	3.9	7.3
Dissolving Sulfite Pulp				
o Nitration	14.5	21.3	26.9	40.8
o Viscose	15.5	21.3	28.7	40.8
o Cellophane	16.8	21.3	31.2	40.8
o Acetate	21.4	21.5	39.6	41.1
Papergrade Sulfite[2]	*	*	*	*
Groundwood-Thermo-Mechanical	2.5	4.6	4.6	8.7
Groundwood-CMN Papers	2.5	3.8	4.6	7.3
Groundwood-Fine Papers	1.9	3.0	3.5	5.8
Secondary Fibers Segment				
Deink				
o Fine Papers	3.1	4.6	5.7	8.7
o Tissue Papers	5.2	6.8	9.6	13.1
o Newsprint	3.2	6.3	6.0	12.0
Tissue From Wastepaper	2.5	5.3	4.6	10.2
Paperboard From Wastepaper				
o Corrugating Medium Furnish	2.1	2.3	3.9	4.4
o Noncorrugating Medium Furnish	1.4	1.8	2.6	3.5
Wastepaper-Molded Products	1.1	2.3	2.1	4.4
Builders' Paper and Roofing Felt	0.94	1.4	1.7	2.7
Nonintegrated Segment				
Nonintegrated-Fine Papers				
o Wood Fiber Furnish	1.9	2.3	3.5	4.4
o Cotton Fiber Furnish	4.2	4.9	7.8	9.5
Nonintegrated-Tissue Papers	3.4	2.6	7.0	6.0
Nonintegrated-Lightweight Papers				
o Lightweight	6.7	5.2	13.7	12.0
o Electrical	11.7	9.2	24.1	21.1
Nonintegrated-Filter and Nonwoven Papers	8.3	6.6	17.1	15.0
Nonintegrated-Paperboard	1.9	1.5	4.0	3.5

pH-Within the range 5.0 to 9.0 at all times

---

*Papergrade Sulfite Equations:

Maximum 30-day average:

$$\text{BOD}_5 = 2.36 \exp(0.017x)$$
$$\text{TSS} = 3.03 \exp(0.017x)$$

Maximum day:

$$\text{BOD}_5 = 4.38 \exp(0.017x)$$
$$\text{TSS} = 5.81 \exp(0.017x)$$

Where x equals percent sulfite pulp produced on-site in the final product

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE XII-2

NEW SOURCE PERFORMANCE STANDARDS
CONVENTIONAL POLLUTANTS
NONCONTINUOUS DISCHARGERS

Subcategory	Annual Average (kg/kkg or lbs/1000 lbs)		Maximum 30-Day Average (mg/l)		Maximum Day (mg/l)	
	BOD5	TSS	BOD5	TSS	BOD5	TSS
Integrated Segment						
Dissolving Kraft	4.4	7.5	40	68	74	129
Market Bleached Kraft	2.9	5.0	36	63	68	120
BCT Bleached Kraft	2.4	4.0	34	57	63	109
Alkaline-Fine[1]	1.6	2.5	29	45	53	85
Unbleached Kraft						
o Linerboard	0.96	1.6	47	79	87	151
o Bag	1.4	2.5	55	98	101	188
Semi-Chemical	0.84	1.6	52	97	97	186
Unbleached Kraft and Semi-Chemical	1.1	2.0	45	79	84	151
Dissolving Sulfite Pulp						
o Nitration	7.6	11.2	59	87	109	166
o Viscose	8.1	11.2	63	87	117	166
o Cellophane	8.8	11.2	68	87	127	166
o Acetate	11.2	11.3	78	79	145	151
Papergrade Sulfite[2]	*	*	62	80	115	153
Groundwood-Thermo-Mechanical	1.3	2.4	44	80	81	153
Groundwood-CMN Papers	1.3	2.0	34	54	63	104
Groundwood-Fine Papers	1.0	1.6	31	46	57	88
Secondary Fibers Segment						
Deink						
o Fine Papers	1.6	2.4	46	69	86	131
o Tissue Papers	2.7	3.6	62	84	116	162
o Newsprint	1.7	3.3	49	92	90	177
Tissue From Wastepaper	1.3	2.8	36	79	67	151
Paperboard From Wastepaper						
o Corrugating Medium Furnish	1.1	1.2	161	171	298	328
o Noncorrugating Medium Furnish	0.73	0.97	105	137	194	263
Wastepaper-Molded Products	0.60	1.2	48	92	89	176
Builders' Paper and Roofing Felt	0.49	0.73	83	122	154	234
Nonintegrated Segment						
Nonintegrated-Fine Papers						
o Wood Fiber Furnish	0.98	1.2	48	56	88	107
o Cotton Fiber Furnish	2.2	2.6	33	38	60	72
Nonintegrated-Tissue Papers	2.3	1.6	43	33	88	76
Nonintegrated-Lightweight Papers						
o Lightweight	4.5	3.2	42	33	87	76
o Electrical	7.9	5.6	42	33	87	76
Nonintegrated-Filter and Nonwoven Papers	5.6	4.0	42	33	87	76
Nonintegrated-Paperboard	1.3	0.94	42	33	87	76

pH-Within the range 5.0 to 9.0 at all times

---

*Papergrade Sulfite (See Equations in Table I-4).

BOD5 Long-Term Average = Maximum 30-day average ÷ 1.91
TSS Long-Term Average = Maximum 30-day average ÷ 1.90

[1] Includes Fine Bleached Kraft and Soda subcategories

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE XII-3

NEW SOURCE PERFORMANCE STANDARDS
TOXIC POLLUTANTS
(kg/kkg or lbs/1000 lbs)

Subcategory	Maximum Day PCP[1]	Maximum Day TCP[2]	Maximum Day Zinc
Integrated Segment			
Dissolving Kraft	0.0025	0.016	NA
Market Bleached Kraft	0.0019	0.012	NA
BCT Bleached Kraft	0.0016	0.010	NA
Alkaline-Fine[3]	0.0014	0.0088	NA
Unbleached Kraft			
o Linerboard	0.00058	0.00053	NA
o Bag	0.00058	0.00053	NA
Semi-Chemical	0.0012	0.00043	NA
Unbleached Kraft and Semi-Chemical	0.00064	0.00059	NA
Dissolving Sulfite Pulp			
o Nitration	0.0030	0.019	NA
o Viscose	0.0030	0.019	NA
o Cellophane	0.0030	0.019	NA
o Acetate	0.0033	0.021	NA
Papergrade Sulfite[4]	*	*	*
Groundwood-Thermo-Mechanical	0.00097	0.00088	0.17
Groundwood-CMN Papers	0.0011	0.00099	0.21
Groundwood-Fine Papers	0.0010	0.00092	0.19
Secondary Fibers Segment			
Deink			
o Fine Papers	0.0030	0.0069	NA
o Tissue Papers	0.0030	0.0069	NA
o Newsprint	0.0030	0.0010	NA
Tissue From Wastepaper	0.0030	0.0011	NA
Paperboard From Wastepaper			
o Corrugating Medium Furnish	0.00087	0.00030	NA
o Noncorrugating Medium Furnish	0.00087	0.00030	NA
Wastepaper-Molded Products	0.0026	0.00088	NA
Builders' Paper and Roofing Felt	0.0017	0.00060	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	0.0018	0.00064	NA
o Cotton Fiber Furnish	0.0051	0.0018	NA
Nonintegrated-Tissue Papers	0.0028	0.00096	NA
Nonintegrated-Lightweight Papers			
o Lightweight	0.0059	0.0020	NA
o Electrical	0.0093	0.0032	NA
Nonintegrated-Filter and Nonwoven Papers	0.0072	0.0025	NA
Nonintegrated-Paperboard	0.0016	0.00054	NA

*Papergrade Sulfite Equations:

$PCP = 0.00058 \exp(0.017x)$
$TCP = 0.0036 \exp(0.017x)$
Where x equals percent sulfite pulp produced on-site in the final product.

[1] PCP = Pentachlorophenol

[2] TCP = Trichlorophenol

[3] Includes Fine Bleached Kraft and Soda subcategories.

[4] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

NA = Not applicable.

TABLE XII-3 (continued)

NEW SOURCE PERFORMANCE STANDARDS
TOXIC POLLUTANTS
NONCONTINUOUS DISCHARGERS
(concentrations mg/l)

Subcategory	Maximum Day		
	PCP[1]	TCP[2]	Zinc
Integrated Segment			
Dissolving Kraft	(0.012)(50.7)/Y	(0.074)(50.7)/Y	NA
Market Bleached Kraft	(0.013)(36.6)/Y	(0.077)(36.6)/Y	NA
BCT Bleached Kraft	(0.012)(31.7)/Y	(0.076)(31.7)/Y	NA
Alkaline-Fine[3]	(0.014)(25.1)/Y	(0.084)(25.1)/Y	NA
Unbleached Kraft			
o Linerboard	(0.015)(9.4)/Y	(0.013)(9.4)/Y	NA
o Bag	(0.012)(11.4)/Y	(0.011)(11.4)/Y	NA
Semi-Chemical	(0.041)(7.3)/Y	(0.014)(7.3)/Y	NA
Unbleached Kraft and Semi-Chemical	(0.013)(11.5)/Y	(0.012)(11.5)/Y	NA
Dissolving Sulfite Pulp			
o Nitration	(0.012)(59.0)/Y	(0.076)(59.0)/Y	NA
o Viscose	(0.012)(59.0)/Y	(0.076)(59.0)/Y	NA
o Cellophane	(0.012)(59.0)/Y	(0.076)(59.0)/Y	NA
o Acetate	(0.012)(65.7)/Y	(0.075)(65.7)/Y	NA
Papergrade Sulfite[4]	*	*	
Groundwood-Thermo-Mechanical	(0.017)(13.8)/Y	(0.015)(13.8)/Y	(3.0)(13.8)/Y
Groundwood-CMN Papers	(0.016)(16.8)/Y	(0.014)(16.8)/Y	(3.0)(16.8)/Y
Groundwood-Fine Papers	(0.016)(15.4)/Y	(0.014)(15.4)/Y	(3.0)(15.4)/Y
Secondary Fibers Segment			
Deink			
o Fine Papers	(0.045)(15.9)/Y	(0.104)(15.9)/Y	NA
o Tissue Papers	(0.036)(19.5)/Y	(0.085)(19.5)/Y	NA
o Newsprint	(0.044)(16.2)/Y	(0.015)(16.2)/Y	NA
Tissue From Wastepaper	(0.045)(16.3)/Y	(0.015)(16.3)/Y	NA
Paperboard From Wastepaper			
o Corrugating Medium Furnish	(0.065)(3.2)/Y	(0.023)(3.2)/Y	NA
o Noncorrugating Medium Furnish	(0.065)(3.2)/Y	(0.023)(3.2)/Y	NA
Wastepaper-Molded Products	(0.107)(5.7)/Y	(0.037)(5.7)/Y	NA
Builders' Paper and Roofing Felt	(0.155)(2.7)/Y	(0.053)(2.7)/Y	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	(0.047)(9.4)/Y	(0.016)(9.4)/Y	NA
o Cotton Fiber Furnish	(0.039)(31.1)/Y	(0.014)(31.1)/Y	NA
Nonintegrated-Tissue Papers	(0.035)(19.1)/Y	(0.012)(19.1)/Y	NA
Nonintegrated-Lightweight Papers			
o Lightweight	(0.037)(38.2)/Y	(0.013)(38.2)/Y	NA
o Electrical	(0.033)(66.8)/Y	(0.012)(66.8)/Y	NA
Nonintegrated-Filter and Nonwoven Papers	(0.037)(47.5)/Y	(0.013)(47.5)/Y	NA
Nonintegrated-Paperboard	(0.033)(11.2)/Y	(0.012)(11.2)/Y	NA

Y = Mill wastewater discharged per ton of product.
NA = Not Applicable

*Papergrade Sulfite Equations:

PCP = ((0.015)(9.12) exp(0.017x))/Y
TCP = ((0.094)(9.12) exp(0.017x))/Y
Where x equals percent sulfite pulp produced on-site in the final product.

[1] PCP = Pentachlorophenol

[2] TCP = Trichlorophenol

[3] Includes Fine Bleached Kraft and Soda subcategories.

[4] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

subcategory. This is because the more efficient treatment systems have not been employed at mills in every subcategory where raw waste loads have been reduced to the levels on which NSPS are based. There is no reason why the NSPS end-of-pipe treatment systems would be less efficient in controlling the conventional pollutant raw waste concentrations that result from implementation of in-plant controls than if these controls were not employed. Therefore, the fact that in some subcategories there is no mill that currently meets final NSPS does not mean that the technologies which form the basis of NSPS are not demonstrated. In fact, final NSPS have been attained at mills where every major pulping and bleaching process (bleached kraft, unbleached kraft, groundwood, semi-chemical, sulfite, deink, and other secondary fiber) and papermaking process are employed. The technologies that form the basis of final NSPS either are now employed or are available for application in every subcategory of the pulp, paper, and paperboard industry and represent the best demonstrated control technology for conventional pollutants.

Toxic Pollutant Control Technology

EPA selected substitution of fungicides and slimicides not containing trichlorophenol or pentachlorophenol as the basis for NSPS because chemical substitution greatly reduces the discharge of these toxic pollutants from new sources. Total removal is not achieved because some wastepapers are contaminated with low levels of PCP and because low levels of TCP are formed when pulp is bleached with chlorine or chlorine-containing compounds. EPA estimates that alternate chemicals are currently being used at approximately 80 percent of the mills in the pulp, paper, and paperboard industry, supporting the Agency's decision to base effluent limitations on chemical substitution. A survey of chemical manufacturers shows that no measurable increase in production costs can be expected as a result of using biocides that do not contain chlorophenolics.

The substitution of sodium hydrosulfite for zinc hydrosulfite to control the discharge of zinc ensures substantial reductions in the discharge of zinc at new direct discharging groundwood mills where zinc could be used as a bleaching chemical. This technology is readily transferable to new direct discharging mills as EPA found that substitution of zinc hydrosulfite with sodium hydrosulfite has been widely practiced at direct discharging groundwood mills to attain existing BPT effluent limitations.

In commenting on proposed NSPS, some commenters stated that tertiary treatment (i.e., chemically assisted clarification or CAC) should form the technology basis of NSPS for the toxic pollutants pentachlorophenol (PCP), trichlorophenol (TCP), and zinc. Chemically assisted clarification (CAC) is an end-of-pipe treatment technology primarily employed to effect a further reduction in suspended solids than can be attained through application of biological treatment only. No data were submitted with comments, nor was the Agency aware of any data, that would allow the EPA to establish a relationship between removal of suspended solids and removal of the three toxic pollutants

(PCP, TCP, and zinc). Therefore, the Agency was unable to establish regulations for control of PCP, TCP, and zinc based on CAC. Further, based on available data, the Agency determined that PCP, TCP, and zinc can be effectively controlled through chemical substitution. As discussed previously, chemical substitution will lead to significant removals of regulated toxics. Thus, EPA based final NSPS controlling PCP, TCP, and zinc on chemical substitution.

METHODOLOGY USED FOR DEVELOPMENT OF NSPS

Conventional Pollutants

NSPS long-term average final effluent characteristics were calculated by multiplying (a) effluent concentrations determined from analysis of control technology performance data for end-of-pipe treatment systems and (b) typical wastewater flow for new sources in each subcategory after implementation of in-plant controls. For most subcategories, as discussed in Section VIII, the NSPS wastewater flow was based on the average of flows less than the flow basis of BPT effluent limitations. Long-term average BOD_5 and TSS effluent concentrations were determined from actual effluent data for operating mills in the pulp, paper, and paperboard industry. The development of final effluent concentrations for each subcategory is discussed in detail in Section VIII.

EPA calculated maximum 30-day and daily maximum mass limitations by multiplying attainable long-term average final effluent loads by appropriate variability factors as discussed in Section VIII.

Toxic Pollutants

Zinc. NSPS for zinc were determined as the product of (a) the maximum discharge concentration that forms the basis of BPT effluent limitations for control of zinc and (b) the flows that form the basis of NSPS for each of the three groundwood subcategories. As explained previously, the Agency expects that this standard will be attained through substitution of sodium hydrosulfite for zinc hydrosulfite in bleaching groundwood pulp.

Trichlorophenol. The Agency assessed TCP discharge characteristics at mills in the pulp, paper, and paperboard industry taking into account whether chlorophenolic-containing biocides were used in the manufacturing process. EPA found that TCP discharges were significantly lower at those mills where chlorophenolic-containing biocides were not used. To determine the discharge levels of TCP that result from substitution of chlorophenolic-containing biocides at new sources, the Agency assessed all available data for existing mills where chlorophenolic-containing biocides were not employed.

EPA found that higher levels of TCP were discharged from existing mills where chlorine-containing compounds were used to bleach pulp than from other mills. This is because low levels of TCP are formed in the bleaching process at mills where chlorine-containing compounds are used to bleach pulp. EPA determined the maximum discharge levels of TCP for existing mills where chlorine-containing compounds were used in the bleaching process and for existing mills where no chlorine-containing compounds were used. Based on all available data, the maximum discharge concentration of trichlorophenol at existing direct discharging mills where chlorophenolic-containing biocides were not used and chlorine-containing compounds were used to bleach pulp was determined to be 68 ug/l. The maximum discharge concentration of trichlorophenol at existing direct discharging mills where chlorophenolic-containing biocides were not used and where chlorine-containing compounds were not used to bleach pulp was determined to be 10 ug/l.

Mass limitations applicable to existing direct discharging mills in each subcategory were calculated as the product of the anticipated maximum day TCP effluent concentrations and the flows that form the basis of BPT for each subcategory. As explained in Section VIII, TCP discharges are directly related to the quantity of pulp bleached and, therefore, should not be affected by water use. Therefore, discharge levels (on a mass basis) at new mills with lower flows should be identical to discharge levels at existing mills. Thus, NSPS are identical to BAT effluent limitations for TCP.

Pentachlorophenol. The Agency assessed PCP discharge characteristics at mills in the pulp, paper, and paperboard industry taking into account whether chlorophenolic-containing biocides were used in the manufacturing process. EPA found that PCP discharges were significantly lower at those mills where chlorophenolic-containing biocides were not used. To determine the discharge levels of PCP that result from substitution of chlorophenolic-containing biocides at new sources, the Agency assessed all available data for mills where chlorophenolic-containing biocides were not employed.

EPA found that higher levels of PCP were discharged from existing mills where wastepapers were processed than from other mills. This is caused by low level PCP contamination of wastepaper. EPA determined the maximum discharge levels of PCP for existing mills where wastepaper was processed and for existing mills where wastepaper was not processed. Based on all available data, the maximum discharge concentration of pentachlorophenol at existing direct discharging mills where chlorophenolic-containing biocides were not used and where wastepaper was processed was determined to be 29 ug/l. The maximum discharge concentration of pentachlorophenol at existing direct discharging mills where chlorophenolic-containing biocides were not used and where wastepaper was not processed was determined to be 11 ug/l.

Mass limitations applicable to existing direct discharging mills in each subcategory were calculated as the product of the anticipated maximum day PCP effluent concentrations and the flows that form the basis of BPT for each subcategory. As explained in Section VIII, PCP discharges are directly related to the quantity of wastepaper processed and, therefore, should not be affected by water use. Therefore, discharge levels (on a mass basis) at new mills with lower flows should be the same as discharge levels at existing mills. Thus, NSPS are identical to BAT effluent limitations for PCP.

A more detailed discussion of the development of toxic pollutant NSPS is presented in Section VIII.

COST OF APPLICATION AND EFFLUENT REDUCTION BENEFITS

The cost of attainment of NSPS varies by subcategory as discussed in Appendix A. EPA estimates that compliance with NSPS will result in incremental capital costs of $19.4 million and total annual costs of $6.9 million (1978 dollars) for the period 1985 to 1990 based on the projected production growth rate. (27) Substantial reductions of BOD_5, TSS, and zinc are ensured while discharges of trichlorophenol and pentachlorophenol resulting from the use of biocides will be virtually eliminated.

NON-WATER QUALITY ENVIRONMENTAL IMPACTS

Non-water quality environmental impacts were considered and are discussed in Appendix A. Energy costs and the cost of disposal of solid wastes were included in Agency estimates of the cost of attainment of new source performance standards. Energy use and solid waste generation will vary at new sources depending on mill size and the subcategory of the pulp, paper, and paperboard industry considered. EPA anticipates that attainment of NSPS will have no measurable impact on air or noise pollution.

SECTION XIII

PRETREATMENT STANDARDS FOR EXISTING SOURCES

GENERAL

Section 307(b) of the Act requires EPA to promulgate pretreatment standards for existing sources (PSES) that must be achieved within three years of promulgation. PSES are designed to control the discharge of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of POTWs. The Clean Water Act of 1977 requires pretreatment for toxic pollutants that pass through the POTW in amounts that would violate direct discharger effluent limitations or interfere with the POTW's treatment process or chosen sludge disposal method. The legislative history of the 1977 Act indicates that pretreatment standards are to be technology-based, analogous to the best available technology for removal of toxic pollutants. EPA has generally determined that there is pass through of pollutants if the percent of pollutants removed by a well-operated POTW achieving secondary treatment is less than the percent removed by the BAT model treatment system. The general pretreatment regulations, which served as the framework for the categorical pretreatment regulations for the pulp, paper, and paperboard industry can be found at 40 CFR Part 403 (43 FR 27736, June 26, 1978; 46 FR 9462, January 28, 1981).

REGULATED POLLUTANTS

EPA established PSES for control of the toxic pollutants trichlorophenol (TCP) and pentachlorophenol (PCP) in all subcategories. PSES were also promulgated for zinc in the groundwood-thermo-mechanical, groundwood-CMN papers, and groundwood-fine papers subcategories. Pentachlorophenol and trichlorophenol have been observed to pass through biological treatment systems. Control of the toxic metal zinc is necessary to minimize sludge disposal problems and pass through of this pollutant.

IDENTIFICATION OF THE TECHNOLOGY BASIS OF PRETREATMENT STANDARDS FOR EXISTING SOURCES

The Agency selected substitution of chemicals as the basis for the control of trichlorophenol, pentachlorophenol, and zinc being discharged to POTWs. Fungicide and slimicide formulations containing trichlorophenol and pentachlorophenol can be replaced with formulations that do not contain these toxic pollutants. Zinc hydrosulfite, a chemical used to bleach groundwood pulps, can be replaced with sodium hydrosulfite.

PSES

PSES are presented in Table XIII-1.

TABLE XIII-1

PRETREATMENT STANDARDS FOR EXISTING SOURCES
(concentrations mg/l)

Subcategory	Maximum Day		
	PCP[1]	TCP[2]	Zinc
Integrated Segment			
Dissolving Kraft	(0.011)(55.1)/Y	(0.082)(55.1)/Y	NA
Market Bleached Kraft	(0.011)(41.6)/Y	(0.082)(41.6)/Y	NA
BCT Bleached Kraft	(0.011)(35.4)/Y	(0.082)(35.4)/Y	NA
Alkaline-Fine[3]	(0.011)(30.9)/Y	(0.082)(30.9)/Y	NA
Unbleached Kraft			
o Linerboard	(0.011)(12.6)/Y	(0.010)(12.6)/Y	NA
o Bag	(0.011)(12.6)/Y	(0.010)(12.6)/Y	NA
Semi-Chemical	(0.032)(10.3)/Y	(0.010)(10.3)/Y	NA
Unbleached Kraft and Semi-Chemical	(0.011)(14.0)/Y	(0.010)(14.0)/Y	NA
Dissolving Sulfite Pulp			
o Nitration	(0.011)(66.0)/Y	(0.082)(66.0)/Y	NA
o Viscose	(0.011)(66.0)/Y	(0.082)(66.0)/Y	NA
o Cellophane	(0.011)(66.0)/Y	(0.082)(66.0)/Y	NA
o Acetate	(0.011)(72.7)/Y	(0.082)(72.7)/Y	NA
Papergrade Sulfite[4]	*	*	
Groundwood-Thermo-Mechanical	(0.011)(21.1)/Y	(0.010)(21.1)/Y	(3.0)(21.1)/Y
Groundwood-CMN Papers	(0.011)(23.8)/Y	(0.010)(23.8)/Y	(3.0)(23.8)/Y
Groundwood-Fine Papers	(0.011)(21.9)/Y	(0.010)(21.9)/Y	(3.0)(21.9)/Y
Secondary Fibers Segment			
Deink			
o Fine Papers	(0.032)(24.4)/Y	(0.082)(24.4)/Y	NA
o Tissue Papers	(0.032)(24.4)/Y	(0.082)(24.4)/Y	NA
o Newsprint	(0.032)(24.4)/Y	(0.010)(24.4)/Y	NA
Tissue From Wastepaper	(0.032)(25.2)/Y	(0.010)(25.2)/Y	NA
Paperboard From Wastepaper			
o Corrugating Medium Furnish	(0.032)(7.2)/Y	(0.010)(7.2)/Y	NA
o Noncorrugating Medium Furnish	(0.032)(7.2)/Y	(0.010)(7.2)/Y	NA
Wastepaper-Molded Products	(0.032)(21.1)/Y	(0.010)(21.1)/Y	NA
Builders' Paper and Roofing Felt	(0.032)(14.4)/Y	(0.010)(14.4)/Y	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	(0.032)(15.2)/Y	(0.010)(15.2)/Y	NA
o Cotton Fiber Furnish	(0.032)(42.3)/Y	(0.010)(42.3)/Y	NA
Nonintegrated-Tissue Papers	(0.032)(22.9)/Y	(0.010)(22.9)/Y	NA
Nonintegrated-Lightweight Papers			
o Lightweight	(0.032)(48.7)/Y	(0.010)(48.7)/Y	NA
o Electrical	(0.032)(76.9)/Y	(0.010)(76.9)/Y	NA
Nonintegrated-Filter and Nonwoven Papers	(0.032)(59.9)/Y	(0.010)(59.9)/Y	NA
Nonintegrated-Paperboard	(0.032)(12.9)/Y	(0.010)(12.9)/Y	NA

Y = Mill wastewater discharged per ton of product.
NA = Not Applicable

*Papergrade Sulfite Equations:

$PCP = ((0.011)(12.67)\ \exp(0.017x))/Y$
$TCP = ((0.082)(12.67)\ \exp(0.017x))/Y$
Where x equals percent sulfite pulp produced on-site in the final product.

[1] PCP = Pentachlorophenol

[2] TCP = Trichlorophenol

[3] Includes Fine Bleached Kraft and Soda subcategories.

[4] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE XIII-1 (continued)

PSES OPTIONAL MASS LIMITS
(kg/kkg or lb/1000 lbs)

Subcategory	Maximum Day		
	PCP[1]	TCP[2]	Zinc
Integrated Segment			
Dissolving Kraft	0.0025	0.019	NA
Market Bleached Kraft	0.0019	0.014	NA
BCT Bleached Kraft	0.0016	0.012	NA
Alkaline-Fine[3]	0.0014	0.011	NA
Unbleached Kraft			
o Linerboard	0.00058	0.00053	NA
o Bag	0.00058	0.00053	NA
Semi-Chemical	0.0014	0.00043	NA
Unbleached Kraft and Semi-Chemical	0.00064	0.00059	NA
Dissolving Sulfite Pulp			
o Nitration	0.0030	0.023	NA
o Viscose	0.0030	0.023	NA
o Cellophane	0.0030	0.023	NA
o Acetate	0.0033	0.025	NA
Papergrade Sulfite[4]	*	*	NA
Groundwood-Thermo-Mechanical	0.00097	0.00088	0.26
Groundwood-CMN Papers	0.0011	0.00099	0.30
Groundwood-Fine Papers	0.0010	0.00092	0.27
Secondary Fibers Segment			
Deink			
o Fine Papers	0.0033	0.0084	NA
o Tissue Papers	0.0033	0.0084	NA
o Newsprint	0.0033	0.0010	NA
Tissue From Wastepaper	0.0034	0.0011	NA
Paperboard From Wastepaper			
o Corrugating Medium Furnish	0.00096	0.00030	NA
o Noncorrugating Medium Furnish	0.00096	0.00030	NA
Wastepaper-Molded Products	0.0028	0.00088	NA
Builders' Paper and Roofing Felt	0.0019	0.00060	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	0.0020	0.00064	NA
o Cotton Fiber Furnish	0.0056	0.0018	NA
Nonintegrated-Tissue Papers	0.0031	0.00096	NA
Nonintegrated-Lightweight Papers			
o Lightweight	0.0065	0.0020	NA
o Electrical	0.010	0.0032	NA
Nonintegrated-Filter and Nonwoven Papers	0.0080	0.0025	NA
Nonintegrated-Paperboard	0.0017	0.00054	NA

Y = Mill wastewater discharged per ton of product.
NA = Not Applicable

*Papergrade Sulfite Equations:

$$PCP = 0.00058 \exp(0.017x)$$
$$TCP = 0.0043 \exp(0.017x)$$

Where x equals percent sulfite pulp produced on-site in the final product.

[1] PCP = Pentachlorophenol

[2] TCP = Trichlorophenol

[3] Includes Fine Bleached Kraft and Soda subcategories.

[4] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

RATIONALE FOR THE SELECTION OF THE TECHNOLOGY BASIS OF PSES

EPA selected substitution of fungicides and slimicides not containing trichlorophenol (TCP) or pentachlorophenol (PCP) as the basis for PSES because chemical substitution greatly reduces the discharge of these toxic pollutants to POTWs. Total removal is not achieved because some wastepapers are contaminated with low levels of PCP and because low levels of TCP are formed when pulp is bleached with chlorine or chlorine-containing compounds. EPA estimates that alternative chemicals are currently being used at approximately 80 percent of the mills in the pulp, paper, and paperboard industry, supporting the Agency's decision to base effluent limitations on chemical substitution. A survey of chemical manufacturers shows that no measurable increase in production costs can be expected as a result of using biocides that do not contain chlorophenolics.

The substitution of sodium hydrosulfite for zinc hydrosulfite to control the discharge of zinc ensures substantial reductions in the discharge of zinc at indirect discharging groundwood mills where zinc is used as a bleaching chemical. This technology is readily transferable to indirect discharging mills as EPA found that substitution of zinc hydrosulfite with sodium hydrosulfite has been widely practiced at direct discharging groundwood mills to attain existing BPT effluent limitations. EPA also determined that substitution to the use of sodium hydrosulfite will not affect the viability of indirect discharging groundwood mills.

In commenting on the proposed regulations, some commenters stated that tertiary treatment (i.e., chemically assisted clarification or CAC) should form the technology basis of the PSES for the toxic pollutants pentachlorophenol (PCP), trichlorophenol (TCP), and zinc. Chemically assisted clarification (CAC) is an end-of-pipe treatment technology primarily employed to effect a further reduction in suspended solids than can be attained through application of biological treatment only. No data were submitted with comments, nor was the Agency aware of any data, that would allow the EPA to establish a relationship between removal of suspended solids and removal of the three toxic pollutants (PCP, TCP, and zinc). Therefore, the Agency was unable to establish regulations for control of PCP, TCP, and zinc based on CAC. Further, based on available data, the Agency determined that PCP, TCP, and zinc can be effectively controlled through chemical substitution. As discussed later in this section, PSES based on chemical substitution will lead to significant removals of regulated toxics. Thus, EPA based final PSES controlling PCP, TCP, and zinc on chemical substitution.

METHODOLOGY USED FOR DEVELOPMENT OF PSES

PSES for the control of pentachlorophenol, trichlorophenol, and zinc were developed using the same general methodology as for development of BAT effluent limitations for control of these toxic pollutants.

Zinc

PSES for zinc are identical to BPT limitations for control of this toxic metal. Standards are based on the maximum anticipated discharge concentration of zinc after the application of lime precipitation. As explained previously, the Agency expects that this standard will be attained through substitution of sodium hydrosulfite for zinc hydrosulfite in bleaching groundwood pulp.

Trichlorophenol

The Agency assessed TCP discharge characteristics at mills in the pulp, paper, and paperboard industry taking into account whether chlorophenolic-containing biocides were used in the manufacturing process. EPA found that TCP discharges were significantly lower at those mills where chlorophenolic-containing biocides were not used. To determine the discharge levels of TCP that result from substitution of chlorophenolic-containing biocides, the Agency assessed all available data for mills where chlorophenolic-containing biocides were not employed.

EPA found that higher levels of TCP were discharged from mills where chlorine-containing compounds were used to bleach pulp than from other mills. This is because low levels of TCP are formed in the bleaching process at mills where chlorine-containing compounds are used to bleach pulp. EPA determined the maximum discharge levels of TCP for mills where chlorine-containing compounds were used in the bleaching process and for mills where no chlorine-containing compounds were used. Based on all available data, the maximum discharge concentration of trichlorophenol at indirect discharging mills where chlorophenolic-containing biocides were not used and chlorine-containing compounds were used to bleach pulp was determined to be 82 ug/l. The maximum discharge concentration of trichlorophenol at indirect discharging mills where chlorophenolic-containing biocides were not used and where chlorine-containing compounds were not used to bleach pulp was determined to be 10 ug/l.

Pentachlorophenol

The Agency assessed PCP discharge characteristics at mills in the pulp, paper, and paperboard industry taking into account whether chlorophenolic-containing biocides were used in the manufacturing process. EPA found that PCP discharges were significantly lower at those mills where chlorophenolic-containing biocides were not used. To determine the discharge levels of PCP that result from substitution of chlorophenolic-containing biocides, the Agency assessed all available data for mills where chlorophenolic-containing biocides were not employed.

EPA found that higher levels of PCP were discharged from mills where wastepapers were processed than from other mills. This is caused by low level PCP contamination of wastepaper. EPA determined the maximum discharge levels of PCP for mills where wastepaper was processed and for mills where wastepaper was not processed. Based on all available data, the maximum discharge concentration of pentachlorophenol at indirect discharging mills where chlorophenolic-containing biocides were not used and where wastepaper was processed was determined to be 32.0 ug/l. The maximum discharge concentration of pentachlorophenol at indirect discharging mills where chlorophenolic-containing biocides were not used and where wastepaper was not processed was determined to be 11 ug/l.

PSES are expressed as allowable maximum daily concentrations (milligrams per liter). Final pretreatment standards include a mathematical formula that accounts for flow differences to assure that the standards do not discourage the implementation of water conservation technologies at indirect discharging mills. Mass limitations (kg/kkg or lb/1000 lb of product) are provided as guidance in cases where it is necessary to impose mass limitations for control of pollutants discharged from contributing pulp, paper, and paperboard mills to POTWs. Mass limitations were calculated as the product of the maximum allowable concentrations and the flows that formed the basis of BPT limitations for each subcategory. A more detailed discussion of the development of PSES limitations is presented in Section VIII.

COST OF APPLICATION AND EFFLUENT REDUCTION BENEFITS

Fungicide and Slimicide Substitution

Other than costs associated with monitoring for TCP and PCP, EPA estimates that there is no cost associated with this technology; substitute chemicals are available at comparable costs. Since PSES do not require monitoring where facilities certify that substitute chemicals are being used to control PCP and TCP, EPA anticipates that monitoring will rarely be required.

EPA estimates that the total mass of regulated pollutants removed from discharges to POTWs will be 3390 kg/yr (7460 lb/yr) of trichlorophenol and 2050 kg/yr (4510 lb/yr) of pentachlorophenol.

Zinc Hydrosulfite Substitution

EPA estimates that the cost (1978 dollars) of implementation of this technology will be $23,300 per year. Only one indirect discharging groundwood mill was identified where zinc hydrosulfite was used to bleach pulp. EPA estimates that the total mass of zinc removed from discharges to POTWs from groundwood subcategory wastewaters will be 20,000 kg/yr (44,000 lb/yr).

NON-WATER QUALITY ENVIRONMENTAL IMPACTS

Sections 304(b) and 306 of the Act require EPA to consider the non-water quality environmental impacts (including air pollution, solid waste generation, and energy requirements) of certain regulations. In conformance with these provisions, the Agency considered the effect of this regulation on air pollution, solid waste generation, and energy consumption. EPA anticipates that compliance with PSES will result in no increase in energy usage nor will these regulations result in any increase in air pollution, noise pollution, or solid waste generation.

SECTION XIV

PRETREATMENT STANDARDS FOR NEW SOURCES

GENERAL

Section 307(c) of the Clean Water Act of 1977 requires EPA to promulgate pretreatment standards for new sources (PSNS) at the same time that it promulgates NSPS. New indirect dischargers, like new direct dischargers, have the opportunity to incorporate the best available demonstrated technologies including process changes, in-plant control measures, and end-of-pipe treatment and to use plant site selection to ensure adequate treatment system installation. Pretreatment standards for new sources (PSNS), like PSES, are to control the discharge of pollutants that pass through, interfere with, or are otherwise incompatible with the operation of POTWs. The Agency considers the same factors in promulgating PSNS as it considers in promulgating PSES.

REGULATED POLLUTANTS

EPA established PSNS for control of the toxic pollutants trichlorophenol (TCP) and pentachlorophenol (PCP) in all subcategories. PSNS were also promulgated for zinc in the groundwood-thermo-mechanical, groundwood-CMN papers, and groundwood-fine papers subcategories. Pentachlorophenol and trichlorophenol have been observed to pass through biological treatment systems. Control of the toxic metal zinc minimizes sludge disposal problems and pass through of this pollutant.

IDENTIFICATION OF THE TECHNOLOGY BASIS OF PRETREATMENT STANDARDS FOR NEW SOURCES

As for PSES, the Agency selected substitution of chemicals as the basis for the control of trichlorophenol, pentachlorophenol, and zinc being discharged to POTWs. Fungicide and slimicide formulations containing trichlorophenol and pentachlorophenol can be replaced with formulations that do not contain these toxic pollutants. Zinc hydrosulfite, a chemical used to bleach groundwood pulps, can be replaced with sodium hydrosulfite.

PSNS

PSNS effluent limitations are presented in Table XIV-1.

RATIONALE FOR THE SELECTION OF THE TECHNOLOGY BASIS OF PSNS

EPA selected substitution of fungicides and slimicides not containing trichlorophenol or pentachlorophenol as the basis for PSNS because chemical substitution greatly reduces the discharge of these toxic pollutants to POTWs from new sources. Total removal is not achieved because some wastepapers are contaminated with low levels of PCP and

TABLE XIV-1

PRETREATMENT STANDARDS FOR NEW SOURCES
(concentrations mg/l)

Subcategory	Maximum Day		
	PCP[1]	TCP[2]	Zinc
Integrated Segment			
Dissolving Kraft	(0.012)(50.7)/Y	(0.089)(50.7)/Y	NA
Market Bleached Kraft	(0.013)(36.6)/Y	(0.093)(36.6)/Y	NA
BCT Bleached Kraft	(0.012)(31.7)/Y	(0.092)(31.7)/Y	NA
Alkaline-Fine[3]	(0.014)(25.1)/Y	(0.101)(25.1)/Y	NA
Unbleached Kraft			
o Linerboard	(0.015)(9.4)/Y	(0.013)(9.4)/Y	NA
o Bag	(0.012)(11.4)/Y	(0.011)(11.4)/Y	NA
Semi-Chemical	(0.045)(7.3)/Y	(0.014)(7.3)/Y	NA
Unbleached Kraft and Semi-Chemical	(0.013)(11.5)/Y	(0.012)(11.5)/Y	NA
Dissolving Sulfite Pulp			
o Nitration	(0.012)(59.0)/Y	(0.092)(59.0)/Y	NA
o Viscose	(0.012)(59.0)/Y	(0.092)(59.0)/Y	NA
o Cellophane	(0.012)(59.0)/Y	(0.092)(59.0)/Y	NA
o Acetate	(0.012)(65.7)/Y	(0.091)(65.7)/Y	NA
Papergrade Sulfite[4]	*	*	
Groundwood-Thermo-Mechanical	(0.017)(13.8)/Y	(0.015)(13.8)/Y	(3.0)(13.8)/Y
Groundwood-CMN Papers	(0.016)(16.8)/Y	(0.014)(16.8)/Y	(3.0)(16.8)/Y
Groundwood-Fine Papers	(0.016)(15.4)/Y	(0.014)(15.4)/Y	(3.0)(15.4)/Y
Secondary Fibers Segment			
Deink			
o Fine Papers	(0.049)(15.9)/Y	(0.126)(15.9)/Y	NA
o Tissue Papers	(0.040)(19.5)/Y	(0.103)(19.5)/Y	NA
o Newsprint	(0.048)(16.2)/Y	(0.015)(16.2)/Y	NA
Tissue From Wastepaper	(0.049)(16.3)/Y	(0.015)(16.3)/Y	NA
Paperboard From Wastepaper			
o Corrugating Medium Furnish	(0.072)(3.2)/Y	(0.023)(3.2)/Y	NA
o Noncorrugating Medium Furnish	(0.072)(3.2)/Y	(0.023)(3.2)/Y	NA
Wastepaper-Molded Products	(0.118)(5.7)/Y	(0.037)(5.7)/Y	NA
Builders' Paper and Roofing Felt	(0.171)(2.7)/Y	(0.053)(2.7)/Y	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	(0.052)(9.4)/Y	(0.016)(9.4)/Y	NA
o Cotton Fiber Furnish	(0.044)(31.1)/Y	(0.014)(31.1)/Y	NA
Nonintegrated-Tissue Papers	(0.038)(19.1)/Y	(0.012)(19.1)/Y	
Nonintegrated-Lightweight Papers			
o Lightweight	(0.041)(38.2)/Y	(0.013)(38.2)/Y	NA
o Electrical	(0.037)(66.8)/Y	(0.012)(66.8)/Y	
Nonintegrated-Filter and Nonwoven Papers	(0.040)(47.5)/Y	(0.013)(47.5)/Y	NA
Nonintegrated-Paperboard	(0.037)(11.2)/Y	(0.012)(11.2)/Y	NA

Y = Mill wastewater discharged per ton of product.
NA = Not Applicable

*Papergrade Sulfite Equations:

PCP = ((0.015)(9.12) exp(0.017x))/Y
TCP = ((0.114)(9.12) exp(0.017x))/Y
Where x equals percent sulfite pulp produced on-site in the final product.

[1] PCP = Pentachlorophenol

[2] TCP = Trichlorophenol

[3] Includes Fine Bleached Kraft and Soda subcategories.

[4] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE XIV-1 (continued)

PSNS OPTIONAL MASS LIMITS
(kg/kkg or lb/1000 lbs)

Subcategory	Maximum Day		
	PCP[1]	TCP[2]	Zinc
Integrated Segment			
Dissolving Kraft	0.0025	0.019	NA
Market Bleached Kraft	0.0019	0.014	NA
BCT Bleached Kraft	0.0016	0.012	NA
Alkaline-Fine[3]	0.0014	0.011	NA
Unbleached Kraft			
o Linerboard	0.00058	0.00053	NA
o Bag	0.00058	0.00053	NA
Semi-Chemical	0.0014	0.00043	NA
Unbleached Kraft and Semi-Chemical	0.00064	0.00059	NA
Dissolving Sulfite Pulp			
o Nitration	0.0030	0.023	NA
o Viscose	0.0030	0.023	NA
o Cellophane	0.0030	0.023	NA
o Acetate	0.0033	0.025	NA
Papergrade Sulfite[4]	*	*	NA
Groundwood-Thermo-Mechanical	0.00097	0.00088	0.17
Groundwood-CMN Papers	0.0011	0.00099	0.21
Groundwood-Fine Papers	0.0010	0.00092	0.19
Secondary Fibers Segment			
Deink			
o Fine Papers	0.0033	0.0084	NA
o Tissue Papers	0.0033	0.0084	NA
o Newsprint	0.0033	0.0010	NA
Tissue From Wastepaper	0.0034	0.0011	NA
Paperboard From Wastepaper			
o Corrugating Medium Furnish	0.00096	0.00030	NA
o Noncorrugating Medium Furnish	0.00096	0.00030	NA
Wastepaper-Molded Products	0.0028	0.00088	NA
Builders' Paper and Roofing Felt	0.0019	0.00060	NA
Nonintegrated Segment			
Nonintegrated-Fine Papers			
o Wood Fiber Furnish	0.0020	0.00064	NA
o Cotton Fiber Furnish	0.0056	0.0018	NA
Nonintegrated-Tissue Papers	0.0031	0.00096	NA
Nonintegrated-Lightweight Papers			
o Lightweight	0.0065	0.0020	NA
o Electrical	0.010	0.0032	NA
Nonintegrated-Filter and Nonwoven Papers	0.0080	0.0025	NA
Nonintegrated-Paperboard	0.0017	0.00054	NA

Y = Mill wastewater discharged per ton of product.
NA = Not Applicable

*Papergrade Sulfite Equations:

PCP = 0.00058 exp(0.017x)
TCP = 0.0043 exp(0.017x)
Where x equals percent sulfite pulp produced on-site in the final product.

[1] PCP = Pentachlorophenol

[2] TCP = Trichlorophenol

[3] Includes Fine Bleached Kraft and Soda subcategories.

[4] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

because low levels of TCP are formed when pulp is bleached with chlorine or chlorine-containing compounds. EPA estimates that alternate chemicals are currently being used at approximately 80 percent of the mills in the pulp, paper, and paperboard industry, supporting the Agency's decision to base effluent limitations on chemical substitution. A survey of chemical manufacturers shows that no measurable increase in production costs can be expected as a result of using biocides that do not contain chlorophenolics.

The substitution of sodium hydrosulfite for zinc hydrosulfite to control the discharge of zinc ensures substantial reductions in the discharge of zinc at new indirect discharging groundwood mills where zinc could be used as a bleaching chemical. This technology is readily transferable to new indirect discharging mills as EPA found that substitution of zinc hydrosulfite with sodium hydrosulfite has been widely practiced at direct discharging groundwood mills to attain existing BPT effluent limitations.

In commenting on proposed PSNS, some commenters stated that tertiary treatment (i.e., chemically assisted clarification or CAC) should form the technology basis of PSNS for the toxic pollutants pentachlorophenol (PCP), trichlorophenol (TCP), and zinc. Chemically assisted clarification (CAC) is an end-of-pipe treatment technology primarily employed to effect a further reduction in suspended solids than can be attained through application of biological treatment only. No data were submitted with comments, nor was the Agency aware of any data, that would allow the EPA to establish a relationship between removal of suspended solids and removal of the three toxic pollutants (PCP, TCP, and zinc). Therefore, the Agency was unable to establish regulations for control of PCP, TCP, and zinc based on CAC. Further, based on available data, the Agency determined that PCP, TCP, and zinc can be effectively controlled through chemical substitution. As discussed previously, chemical substitution will lead to significant removals of regulated toxics. Thus, EPA based final PSNS controlling PCP, TCP, and zinc on chemical substitution.

METHODOLOGY USED FOR DEVELOPMENT OF PSNS

PSNS for the control of pentachlorophenol, trichlorophenol, and zinc were developed using the same general methodology used in the development of PSES effluent limitations for control of these toxic pollutants. PSNS are expressed as allowable maximum daily concentrations (milligrams per liter). Final pretreatment standards include a mathematical formula that accounts for flow differences to assure that the standards do not discourage the implementation of water conservation at indirect discharging new sources. Mass limitations (kg/kkg or lb/1000 lb of product) are provided as guidance in cases where it is necessary to impose mass limitations for control of pollutants discharged from contributing pulp, paper, and paperboard mills to POTWs.

PSNS mass limits for PCP and TCP are identical to PSES mass limits. The allowable maximum daily concentrations for new source indirect dischargers were calculated by dividing the PSES mass limits by the flow basis on which NSPS are based for each subcategory. As discussed in Section VIII, mass limits for zinc were determined as the product of the maximum zinc discharge concentration that forms the basis of BPT limitations and the flows that form the basis of NSPS for each of the three groundwood subcategories.

A more detailed discussion of the development of PSNS is presented in Section VIII.

COST OF APPLICATION

The technology basis of PSNS is identical to the technology basis of PSES -- chemical substitution to limit the discharge of PCP, TCP, and zinc. Therefore, there is no incremental cost attributable to PSNS.

NON-WATER QUALITY ENVIRONMENTAL IMPACTS

Sections 304(b) and 306 of the Act require EPA to consider the non-water quality environmental impacts (including air pollution, solid waste generation, and energy requirements) of certain regulations. In conformance with these provisions, the Agency considered the effect of this regulation on air pollution, solid waste generation, and energy consumption. EPA anticipates that compliance with PSNS will result in no increase in energy usage nor will it result in any increase in air pollution, noise pollution, or solid waste generation.

SECTION XV

ACKNOWLEDGEMENTS

The U.S. Environmental Protection Agency wishes to acknowledge the contributions to this project by the E C. Jordan Co., of Portland, Maine. Donald R. Cote, P.E., Vice President-Operations, Willard C. Warren III, P.E., Project Manager, John C. Tarbell, P.E., Assistant Project Manager, Conrad R. Bernier, Senior Project Engineer, Robert E. Handy, P.E., Project Engineer, and Charles D. Cox, P.E., Senior Project Engineer, were the key contributors in completion of the detailed technical study and the drafting of the initial report on which this document is based. Other personnel who contributed in the project investigations were Neal A. Jannelle, Laurance C. Barbour, Nancy E. Forrester, Deborah A. Luciano, and Edward J. Doyle, of the E.C. Jordan Co. and Raymond H. Myers, Ph.D., Statistical Consultant of Virginia Polytechnic Institute, and Roger A. Novack, Ph.D., formerly of Gulf South Research Institute.

We wish to acknowledge the mill managers, engineers, and other representatives of the industry without whose cooperation and assistance in site visitations and information gathering, the completion of this project would have been greatly hindered. The National Council of the Paper Industry for Air and Stream Improvement and the American Paper Institute BAT Task Group deserve special recognition.

The EPA also thanks personnel in the EPA regional offices and state agencies who supplied discharge monitoring report (DMR) data and related information. Contributing to this effort were EPA staff in Regions I, II, III, IV, VI, VIII, IX, and X and personnel in the following state agencies: Maine, New Hampshire, Connecticut, New York, Virginia, Delaware, Tennessee, Mississippi, Alabama, Georgia, South Carolina, North Carolina, Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Kansas, Iowa, California Region I, and California Region V (Redding Office).

The U.S. EPA Pulp and Paper Technical Working Group must also be recognized for their valuable contributions:

Danforth G. Bodien	U.S. EPA, Region X
Joseph Davis	U.S. EPA, Region III
Jack Newman	U.S. EPA, Region V
Gary Milburn	U.S. EPA, Region V
Frank Early	U.S. EPA, NEIC-Denver
Michael Strutz	U.S. EPA, OR&D - Cincinnati
Michael Tiami	U.S. EPA, Region IV
Charles Whittier	U.S. EPA, Region VI
Robert Gross	State of South Carolina
Vincent Carpano	State of Virginia
Paul Didier	State of Wisconsin

Appreciation is expressed to those at EPA Headquarters who contributed to the completion of this project, including: Louis DuPuis, Renee Rico, John Kukulka, Henry Kahn, Richard Kotz, Allen Leduc, Dale M. Ruhter, Edward Sharter, Gail Coad, William Webster, and David Gibbons, Office of Analysis and Evaluation, Office of Water Regulations and Standards; Alexander McBride, Fred Leutner, Alexandra Tarnay, Lynn Delpire, Rod Frederick, Edmund M. Notzon, Monitoring and Data Support Division, Office of Water Regulations and Standards; L. Michael Flaherty, Donald Ehreth, Patrick Tobin, and Joseph A. Krivak, Criteria and Standards Division, Office of Water Regulations and Standards; Richard Gardner, Nancy Othmer, Bruce Diamond, Gail Cooper, and Susan G. Lepow, Office of General Counsel; J. William Jordan and Richard Brandes, Office of Water Enforcement; Richard Raines and Mahesh Podar, Office of Planning and Evaluation; and Matthew Straus, Office of Solid Waste.

Within the Effluent Guidelines Division, Robert Southworth, Linda Wilbur, Devereaux Barnes, John E. Riley, Robert B. Schaffer, Jeffery D. Denit, Arthur Shattuck, Craig Vogt, Mark Mjonness, Teresa Wright, Gregory Aveni, Maureen Treacy, and Lois Jennings made significant contributions. The performance and long hours contributed by Carol Swann are appreciated, as are the efforts of Glenda Colvin, Glenda Nesby, and Pearl Smith.

We also wish to acknowledge Raymond C. Loehr, Ph.D., Professor of Agricultural Engineering and Environmental Engineering, Cornell University, a special friend of the Effluent Guidelines Division, who helped us over the last hurdle.

APPENDIX A

COST, ENERGY, AND NON-WATER QUALITY ASPECTS

Previous sections described the respective BPT, BAT, PSES, PSNS, and NSPS control options that were considered as the basis of regulations. This section summarizes the cost, energy, and other non-water quality impacts of the various control and treatment options. The other non-water quality aspects addressed in this document are (a) implementation requirements, (b) air pollution, (c) noise pollution, and (d) solid waste.

METHODOLOGY FOR DEVELOPMENT OF COSTS

Introduction

This section describes how EPA developed estimates of the cost of implementation of the control and treatment technology options considered in regulation development. The actual cost of implementing these control and treatment options can vary at each individual facility, depending on the design and operation of the production facilities and local conditions. EPA developed control and treatment costs that are representative of each subcategory of the pulp, paper, and paperboard industry based on engineering estimates. Where possible, the cost estimates were compared to costs reported by industry and were revised, where appropriate. Accounting procedures used at different mills vary, thus complicating the use of industry cost data.

In order to assess the overall impact of the various treatment and control options on the pulp, paper, and paperboard industry, EPA developed model mill costs for 31 distinct subcategories and sub-groups of the various subcategories. Costs were developed for BPT, BAT, and NSPS treatment options for direct dischargers and for PSNS and PSES technology options for indirect dischargers. The model mill approach, mill and site specific cost factors, and cost estimating criteria are discussed below.

Model Mill Approach

The costs of implementation of various control and treatment options were estimated in order to determine the economic impact of each technology option. In order to develop costs, EPA developed model mills that are representative of mills in each of the subcategories of the pulp, paper, and paperboard industry. In order to properly reflect the effect of mill size on costs, as many as three different model mill sizes were selected for the respective subcategories. EPA based model mill sizes on the actual variation of size within each subcategory; model mill sizes are presented by subcategory in Table A-1.

TABLE A-1

MODEL MILL SIZES BY SUBCATEGORY AND DISCHARGE TYPE

	Indirect Dischargers (kkg/d)		Direct Dischargers (kkg/d)	
Subcategory	Existing	New	Existing	New
Integrated Segment				
Dissolving Kraft	NA	NA	907	907
Market Bleached Kraft	NA	NA	318 544 1,451	680
BCT Bleached Kraft	NA	NA	272 726 1,179	454
Alkaline-Fine[1]	NA	NA	181 726 1,089	680
Unbleached Kraft				
o Linerboard	NA	NA	408 907 1,361	454
o Bag	NA	NA	408 907 1,361	907
Semi-Chemical	NA	NA	181 386 544	454
Unbleached Kraft and Semi-Chemical	NA	NA	635 1,361 2,359	1,361
Dissolving Sulfite Pulp	NA	NA	408 544	454
Papergrade Sulfite[2]	NA	NA	91 408 907	680
Groundwood-Thermo-Mechanical	NA	NA	272	454
Groundwood-CMN Papers	45 544 907	45 544 907	45 544 907	454
Groundwood-Fine Papers	NA	68 454 680	68 454 680	454
Secondary Fibers Segment				
Deink				
o Fine Papers	NA	NA	163 363 726	454
o Tissue Papers	NA	NA	23 45 163	91 454
o Newsprint	NA	NA	NA	454

TABLE A-1
(continued)

Subcategory	Indirect Dischargers (kkg/d) Existing	Indirect Dischargers (kkg/d) New	Direct Dischargers (kkg/d) Existing	Direct Dischargers (kkg/d) New
Tissue From Wastepaper	NA	9	9	9
		36	36	
Paperboard From Wastepaper	45	45	45	91
	145	145	145	454
	635	635	635	
Wastepaper-Molded Products	NA	NA	18	45
			45	
			136	
Builders' Paper and Roofing Felt	NA	NA	91	68
			204	136
Nonintegrated Segment				
Nonintegrated-Fine Papers				
o Wood Fiber Furnish	NA	NA	32	227
			195	
			907	
o Cotton Fiber Furnish	NA	NA	9	27
			45	
			91	
Nonintegrated-Tissue Papers	NA	NA	32	45
			163	227
			907	
Nonintegrated-Lightweight Papers	NA	NA	9	45
			54	
			181	
Nonintegrated-Filter and Nonwoven	NA	NA	5	23
			18	
			41	
Nonintegrated-Paperboard	NA	NA	9	45
			36	
			68	

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

Mill and Site Specific Cost Factors

Specific mills in a subcategory can be expected to differ in certain respects from the representative model mills. These differences can alter the costs for achieving the various effluent quality levels specified for each subcategory. Among the factors affecting costs are location, climate, mill age, savings resulting from implementation of various controls, retrofit requirements, site limitations, raw wastewater quality, and production capacity. In addition, at certain mills, different combinations of production processes are now employed.

Location. Differences exist in construction practice, labor rates, and energy costs due to geographic location. EPA based model mill costs on national averages. Regional cost factors are presented in Table A-2 for the purpose of adjusting model mill costs to be representative of specific geographic areas.(210)(211)(212)(213)

Climate. Biological treatment systems constructed in cold climates often require longer detention times than those constructed in warmer climates; this is due to bio-kinetic relationships (see Section VII). Longer detention time requires higher capital and operating costs. The costs presented are reflective of design in areas of moderate climate and represent the median values anticipated to be incurred.

Climate can also affect the construction details of the various components. Open pit pumps, above ground piping, and exposed process equipment are characteristic of warm climate mills, while at mills in colder climates such designs cannot be utilized. Model mill cost estimates reflect design based on cold climates. At those mills in warm climates, lower costs may be realized than are reflected in the cost estimates.

Production Capacity. Economies of scale can be realized with increasing size and are likely to vary depending on the equipment to be constructed. In order to account for the effect of mill size, each control and treatment option was evaluated over a representative range of mill sizes for each subcategory.

Age. Mill age can impact the cost of implementing various process controls. This factor was considered in the development of model mill costs by accounting for the relative difficulty of installing and replacing process equipment and effluent sewers.

The chronological age of a mill, however, is not always a good measure of the relative ease with which controls may be implemented. This results from the fact that at older mills, extensive rebuilding or expansion programs have been implemented, often resulting in conditions that allow for ease of installation of additional production process controls.

TABLE A-2

REGIONAL COST ADJUSTMENT FACTORS

Region/State	Capital (210)	Operation and Maintenance (211)(212)	Energy (213)
Northeast	1.03	0.97	1.38
North Central	1.02	1.15	1.18
South	0.90	0.81	1.17
Plains/Mountain	0.96	0.99	1.02
West	1.09	1.12	0.79
Alaska	1.38	1.78	1.16

Material and Energy Savings. Where production process controls were considered, more efficient mill operation and substantial savings of material and energy can result. Material and energy savings were taken into account where appropriate and net costs of operation, maintenance, and energy are presented.

Other Savings. There are other possible savings that may result from implementation of production process controls in addition to savings in materials and energy. Such additional savings, which are not accounted for in the cost estimates presented in this document, include the benefits that result from improved recovery systems and the manufacture of by-products such as black liquor soap, turpentine, solvents, glues, and human and animal nutrients. The recycle of effluent streams may also allow for heat recovery that can represent savings at some mills, particularly in colder climates. Such savings may not be common to all mills in a subcategory, but may be realized at some mills depending on such factors as location and production processes employed.

Retrofit Requirements. EPA based BAT model mill costs on the assumptions that (a) production process and effluent treatment controls that form the basis of BPT effluent limitations have been installed and (b) all facilities are currently attaining BPT effluent limitations. For those cases where mills are not currently attaining existing BPT effluent limitations, an additional cost for retrofitting existing treatment may be incurred if predicted levels of discharged pollutants are to be attained. These costs are not accounted for in the cost estimates presented in this document as these costs have been accounted for in previous rulemaking efforts.(48)

Site Limitations. The implementation of additional production process controls or end-of-pipe treatment technologies can require additional land. Spatial relationships and the physical characteristics of available land can affect construction costs. The impact of mill-by-mill variations are lessened because the options being considered are not land intensive. In addition, where treatment facilities such as clarifiers are added, the cost of pumping to these facilities is included. For those facilities where gravity flow is possible, costs are considerably overstated.

Analysis of information obtained during the data request program indicates that for two-thirds of the operating facilities, land availability is not a problem. For that reason and because of the extensive variability of land acquisition costs, the cost of land acquisition was not included in cost estimates.

Raw Wastewater Characteristics. Flow, BOD_5, and TSS loadings at individual mills may vary from those of the model mill. These variations can affect the cost of effluent treatment. However, the model mill approach to cost development yields representative costs within an acceptable confidence interval without requiring specific engineering studies at each mill in the industry. It is likely that the approach to achieving effluent limitations chosen by management at individual mills will vary from that considered in establishing the specific limitations. EPA anticipates that mill management will choose the technology that is most cost-effective for each facility.

Cost Estimating Criteria for Control and Treatment Technologies

EPA developed capital, operation and maintenance, and energy cost estimates based on the criteria presented in Table A-3. (211)(212)(213)(214)(215)(216)(217) The pre-engineering cost estimates developed for this study are expected to have a variability consistent with this type of estimate and are on the order of plus or minus 30 percent.

Capital Cost Criteria. All costs presented in this section, except as noted, are in terms of first quarter 1978 dollars. Since construction costs escalate, these estimates may be adjusted through use of appropriate cost indices. The most accepted and widely-used cost index in the engineering field is the Engineering News Record (ENR) construction cost index. The ENR index value of 2,683 used in this report was taken from the "U.S. - 20 Cities Average" for first quarter 1978.(214)

Equipment costs were based on supplier quotes, published literature, engineering experience, and data request program mill responses. Capital costs include allowances for lost production during construction or for additional power facilities as warranted. Additional costs such as engineering and contingencies were based on a percentage of capital and vary from 15 to 25 percent depending on the technology.

A total labor rate of $23.00 per hour was assumed for installation of production process controls. This wage rate is based upon a $19.00 national average wage rate including fringe benefits plus a net supervision rate of $4.00 per hour.(218) Construction and installation cost estimates for effluent treatment were determined as an appropriate varying percentage of capital.

Annual Fixed Charges. The annual fixed charges are those annual costs that are directly related to the construction of pollution abatement facilities. These charges commonly include such items as depreciation of the control equipment and interest on the capital borrowed for construction. In addition, such costs as maintenance materials, spare parts, insurance, and taxes are expressed as a percentage of initial capital expenditures.

The useful life of each structure and mechanical unit varies. Mechanical equipment operating in demanding service conditions may have a useful life of 5 to 10 years compared to a building which may have a useful life of 40 to 50 years or more. Depreciation costs are those accounting charges for the eventual replacement of a given asset (equipment or structure) at the end of its useful life. Depreciation of the capital assets may be by accumulation of digits (rapid depreciation) or method of averages (straight-line). A NCASI report

TABLE A-3

COST ESTIMATING CRITERIA[1]

1.	Capital costs are as of first quarter 1978:		ENR = 2,683
2.	Annual fixed (amortized) costs are 22% of capital expenditures		
3.	Energy:	Electrical	$0.0325/kwh
		Fuel	$12.00/barrel
4.	Operation and Maintenance:		
	Labor:	General	$10.35/hr
		Solids disposal	$ 8.00/hr
	Chemicals:	alum	$110/kkg, dry basis
		polymer	$4.41/kg
		85% phosphoric acid	$0.44/kg
		anhydrous ammonia	$154/kkg, dry basis
		50% sodium hydroxide	$165/kkg
		100% sulfuric acid	$56/kkg

---

[1] Sources of Cost Data:

Employment and Earnings, U.S. Bureau of the Census, April 1978. (211)

Employee Benefits 1977, Chamber of Commerce of the U.S.A., April 1978. (212)

Energy User News, Vol. 3, No. 32, August 7, 1978. (213)

Engineering News Record, March 23, 1978. (214)

Monthly Energy Review, U.S Department of Energy, March 1979. (215)

Municipal Sludge Landfills, EPA-625/1-78-010, U.S. Environmental Protection Agency, Process Design Manual, October 1978. (216)

Chemical Marketing Reporter, November 6, 1978. (217)

shows an average depreciation rate in the industry of 16.5 years (219)

Interest is that annual charge for financing the capital expenditures for construction of a facility. Such financing may be through corporate bonds, conventional lending markets, or tax-exempt municipal revenue bonds. Municipal revenue bonds have lower interest rates compared to corporate bonds. A NCASI report states that 44 percent of the pollution abatement expenditures in 1976 were financed through tax-exempt municipal bonds. (219)

Costs for taxes, insurance, spare parts, and maintenance materials are often expressed as a percentage of the capital investment.

For the purpose of calculating total annual costs, EPA used an average fixed charge of 22 percent of the capital expenditures. This figure includes all of the above items. EPA realizes that these charges may vary and are dependent upon several factors, such as the complexities of the system installed, financing availability, insurance coverage, property tax credits, spare parts inventory, and maintenance materials.

Energy Costs. An average national electric power cost for large industrial users (200,000 kwh monthly, 1,000 kw demand) was estimated at $0.0366/kwh. This figure was derived from average cost information by state and on electric rates from approximately 200 public and private utilities.(213) Information concerning actual revenues from approximately 200 public and private utilities indicated a cost of $0.0281/kwh. (213) Based on that data, energy costs were estimated at $0.0325/kwh.

Fuel for steam generation was estimated at $12 per barrel. (215)

Operating and Maintenance Labor. The average nonsupervisory labor rate in the pulp and paper industry was reported to be $7.14 per hour in February 1978.(211) Average total benefits for the pulp, paper, lumber, and furniture industry for the year 1977 were reported as 34 percent of wages.(212) Although no industry-wide data concerning supervisory costs were available, the proposed control and treatment technologies under consideration are anticipated to require only minimal additional supervisory labor.

A supervisory and benefits cost of 45 percent of the labor rate was assumed. This results in a total labor rate of $10.35/hr.

Chemicals. Chemical costs were based on quotes from chemical suppliers and chemical marketing reports. Many of the technologies under evaluation include the use of chemicals, including alum, polymer, phosphoric acid, sulfuric acid, anhydrous ammonia, and sodium hydroxide.

COSTS FOR IMPLEMENTATION OF BPT

EPA identified four new subcategories of the pulp, paper, and paperboard industry (wastepaper-molded products, nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard). In Section VIII, BPT was identified for these subcategories. In this section, estimates of the incremental cost to achieve BPT effluent limitations are presented.

For the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories, BPT was identified as primary treatment. At the direct discharging mills in these three nonintegrated subcategories, in-place end-of-pipe treatment consists of primary treatment (or its equivalent) or more advanced treatment technology (i.e., biological treatment). Therefore, EPA anticipates that the incremental cost of attainment of BPT in these subcategories is zero.

BPT was identified as biological treatment for the wastepaper-molded products subcategory. In general, at the direct discharging mills in this subcategory, primary treatment or its equivalent is in-place. EPA's estimate of the incremental costs for attainment of BPT effluent limitations was based on the addition of a biological treatment system. Major unit operations include (a) wastewater pumping, (b) flow equalization, (c) nutrient addition, (d) addition of an activated sludge basin with aerators, (e) flotation thickening with chemical addition, (f) solids dewatering with chemical addition, (g) biological sludge transportation to landfill, and (h) landfill of biological solids.

The design criteria on which costs were determined for each of the major unit processes are presented in Table A-4. The total capital and total annual costs for compliance with BPT are presented for the wastepaper-molded products subcategory in Table A-5.

BPT limitations were also promulgated for new subdivisions of the paperboard from wastepaper and nonintegrated-fine papers subcategories. As a result of comments on the proposed rules, EPA obtained additional data relating to mills in these subcategories (see Section IV). The Agency determined that higher raw waste loads result at paperboard from wastepaper mills where corrugating medium is used as furnish; therefore, BPT effluent limitations applicable to discharges from these mills were modified. As discussed previously, less stringent BPT effluent limitations than were previously in effect now apply to existing direct discharging mills in the paperboard from wastepaper subcategory where recycled corrugating medium is processed. For this reason, no costs are associated with attainment of these modified BPT limitations.

Subsequent to proposal, the Agency reexamined the subcategorization scheme for the nonintegrated-fine papers subcategory. As discussed previously, EPA's review of data for the nonintegrated-fine papers subcategory revealed that segmentation was warranted because mills

TABLE A-4

DESIGN CRITERIA FOR BPT ACTIVATED SLUDGE TREATMENT WASTEPAPER-MOLDED PRODUCTS SUBCATEGORY

Wastewater Pumping
- Design flow: 1.5 x average annual flow
- Basis for power cost: 12 m total dynamic head, 70% efficient

Flow Equalization
- Detention time: 12 hrs in concrete basin

Primary Clarification
- Overflow rate: 24 cu m/d/sq m
- Sidewater depth: 4 m

Secondary Clarification
- Overflow rate: 20 cu m/d/sq m
- Sidewater depth: 4 m

Activated Sludge Basin
- Number of basins: 2
- Loading rate (use larger value):
  - 0.8 kg BOD5 applied/cu m/d, or
  - 8 hr hydraulic detention time
- Nutrient feed: BOD5 removed:N:P = 100:5:1
- Aeration design requirements:
  - 1.5 organic peaking factor
  - 1 kg O_2 /kg BOD5 removed
  - 19 kg O_2 /aerator hp/d
- Length/width ratio: 4/1
- Sidewater depth: 4 m
- Sideslopes: 1/1

Dissolved Air Flotation Thickening for Biological Solids
- Sludge loading rate: 10 kg/hr/sq m
- Hydraulic loading rate: 46.9 cu m/d/sq m
- Chemical dosage: 4 kg of polymer/kkg of solids

Solids Dewatering
- Type: horizontal belt-filter press
- Loading rate: 318 kg of dry solids/hr/m of belt width
- Chemical dosage: 4 kg of polymer/kkg of solids

Primary/Biological Sludge Transportation
- Haul distance: 16 km
- Sludge content: primary and biological sludge at 30 percent solids (w/w)

Primary/Biological Sludge Landfill
- Sludge content: primary and biological sludge at 30 percent solids (w/w)
- Landfill design: normal landfill compaction and covering techniques

---

TABLE A-5

COST OF IMPLEMENTATION OF BPT ACTIVATED SLUDGE TREATMENT WASTEPAPER-MOLDED PRODUCTS SUBCATEGORY

Mill Size (kkg/d)	Capital ($1,000)	Operation and Maintenance ($1,000/yr)	Energy ($1,000/yr)	Total Annual ($1,000)
18	891	81	11	288
45	1,542	113	19	471
136	3,015	176	41	879

where cotton fibers comprise a significant portion of the final product (equal to or greater than four percent) have higher raw waste flow and BOD_5 than mills where only wood pulp is processed. In this rulemaking, EPA established BPT limitations applicable to discharges from these mills that are less stringent than for other facilities in the nonintegrated-fine papers subcategory. The Agency anticipates that there will be no costs associated with attainment of BPT effluent limitations in the cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory because existing permits for the two direct discharging mills are more stringent than the BPT effluent limitations.

COSTS FOR IMPLEMENTATION OF BAT OPTIONS

Toxic Pollutant Control Options

The Agency evaluated two options for control of toxic pollutants in pulp, paper, and paperboard industry discharges. They are (a) control of zinc at groundwood mills through the application of lime precipitation and control of pentachlorophenol (PCP) and trichlorophenol (TCP) through substitution of biocides containing PCP and TCP with those that do not and (b) control of chloroform through the application of additional aeration.

Option 1. This includes the application of lime precipitation, the technology basis of BPT effluent limitations, for control of zinc in the groundwood subcategories and chemical substitution to control PCP and TCP in every subcategory. The Agency determined that at all direct discharging groundwood mills, BPT zinc limits are now being met through substitution of sodium hydrosulfite for zinc hydrosulfite as a bleaching chemical. Therefore, the Agency anticipates that there will be no incremental costs associated with attainment of zinc limits based on this technology option.

The technology basis for control of PCP and TCP in all subcategories is substitution to the use of biocides not containing these compounds. Based on the results of verification sampling, process chemicals containing pentachlorophenol were used at ten of the 60 sampled mills; chemicals containing trichlorophenol were used at six of the sampled mills. Correspondence with mill personnel indicate that: (a) at six of the mills, PCP-containing process chemicals are no longer used and (b) at four of the mills, TCP-containing process chemicals are no longer used. Inquiries of chemical suppliers on the relative costs of substitute chemicals indicate that no definable cost difference will result from chemical substitution.

Option 2. This technology option includes the application of additional aeration at nine mills where (a) chlorine or chlorine-containing compounds are used to bleach pulp and (b) closed biological systems are used that inhibit volatilization of chloroform. Table A-6 presents the design criteria for the additional aeration step and Table A-7 presents chloroform control costs for the nine mills.

TABLE A-6

DESIGN CRITERIA FOR CHLOROFORM CONTROL AT NINE MILLS WHERE CHLOROFORM VOLATILIZATION IS INHIBITED

Earthen Basin
- Loading rate (use larger value):
  - *0.8 kg BOD5 applied/cu m/d, or
  - 8 hr hydraulic detention time
- Aeration design requirements:
  - 19 kg O_2 BOD5/d/aerator HP
- Sidewater depth: 4 m
- Sideslopes: 1/1
- Leachate collection
- Synthetic liner

---

* Based on BOD5 raw waste load.

TABLE A-7

COST FOR CHLOROFORM CONTROL AT NINE MILLS WHERE CHLOROFORM VOLATILIZATION IS INHIBITED

Treatment System/ Subcategory	Mill Number	Capital ($1,000)	Operation and Maintenance ($1,000/yr)	Energy ($1,000/yr)	Total Annual ($1,000)
Oxygen Activated Sludge					
Integrated-Miscellaneous					
	010010	2,217	53	484	1,025
	010012	1,235	36	252	560
	010015	1,539	41	320	700
	010059	1,223	36	250	555
Alkaline-Fine and Papergrade Sulfite[1]					
	030051 and 040009	3,133	66	699	1,454
Deep Tank Aeration					
Dissolving Sulfite	046002	4,622	85	1,075	2,177
	046005	3,897	76	895	1,828
Papergrade Sulfite	040017	1,581	42	332	722
TOTAL		19,447	435	4,307	9,021

---

[1] Joint treatment.

Nonconventional Pollutant Control Options

Technologies available for removal of nonconventional pollutants include: (a) color removal by minimum lime or alum coagulation; and (b) ammonia removal by biological nitrification or substitution of chemical pulping bases. The method of developing cost data and the costs associated with these respective technologies are presented below.

Color Removal. Estimates of costs for color removal were prepared for two alternative treatment technologies: minimum lime coagulation and alum coagulation. Costs are presented in Table A-8 for both technologies for those subcategories identified as having high levels of color in effluent discharges.

Minimum Lime Coagulation - Minimum lime coagulation treatment for color load reduction in the four bleached kraft, the dissolving sulfite pulp, and the two papergrade sulfite subcategories is applied only to highly-colored wastewater streams. These streams normally represent only about one-quarter to one-third of total wastewater discharge from a mill. The streams required to be treated would be the highly-colored bleach plant wastewater (first stage caustic extraction waste stream) and the screen room (decker or pulp mill) wastewater. For the remaining subcategories (unbleached kraft, semi-chemical, and unbleached kraft and semi-chemical), minimum lime is applied to the total wastewater discharge because (a) the flow is much lower for mills in these subcategories and (b) the color does not tend to be concentrated in streams of lesser flow.

The costs for the minimum lime system are based on the following items:

1. wastewater transfer pump,
2. mixing (in-line mixer),
3. lime feed system,
4. polymer feed system,
5. clarifier,
6. sludge holding tank with mixer,
7. lime mud dewatering system,
8. fluidized bed for lime mud incineration, and
9. pH adjustment following minimum lime treatment in those cases where the total mill effluent is treated.

A wastewater transfer pump with ancillary piping transports the first caustic stage effluent from the bleach plant to the minimum lime treatment system. An in-line mixer combines the lime slurry with the wastewater. For the purpose of the cost estimate, a lime dosage of 2,250 mg/l was assumed. Wastewater then flows to a color reduction clarifier. A polymer is metered into the wastewater stream prior to the clarifier to aid in settling the lime precipitate. Other settling aids (such as fiber fines) can also be used at this point in the minimum lime process.

TABLE A-8

COST FOR COLOR REDUCTION FOR DIRECT DISCHARGERS

Subcategory and Mill Size	Capital ($1,000)	Amortized Capital ($1,000/yr)	Operation and Maintenance Labor ($1,000/yr)	Operation and Maintenance Chemicals ($1,000/yr)	Energy ($1,000/yr)	Total Annual ($1,000)
Dissolving Kraft						
907 kkg/d						
Lime	5,591	1,230	151	867	1,218	3,466
Alum	13,039	3,031	912	3,520	243	7,706
Market Bleached Kraft						
318 kkg/d						
Lime	2,100	462	89	174	245	970
Alum	5,752	1,313	476	912	75	2,776
544 kkg/d						
Lime	2,880	634	101	278	405	1,417
Alum	7,886	1,809	597	1,561	116	4,083
1451 kkg/d						
Lime	5,145	1,132	143	1,070	771	3,116
Alum	14,129	4,095	914	4,163	275	9,447
BCT Bleached Kraft						
272 kkg/d						
Lime	1,897	417	86	146	205	854
Alum	5,054	1,155	444	676	60	2,335
726 kkg/d						
Lime	3,450	759	111	370	545	1,785
Alum	8,996	2,073	671	1,801	134	4,679
1179 kkg/d						
Lime	4,545	1,000	132	610	875	2,617
Alum	12,018	2,781	830	2,927	205	6,743
Alkaline-Fine[1]						
181 kkg/d						
Lime	1,380	304	82	92	140	618
Alum	3,678	838	371	400	41	1,650
726 kkg/d						
Lime	3,450	759	111	370	545	1,785
Alum	8,199	1,894	658	1,592	122	4,266
1089 kkg/d						
Lime	4,350	957	127	556	805	2,445
Alum	10,423	2,419	784	2,391	173	5,767
Unbleached Kraft						
408 kkg/d						
Lime	2,724	599	100	308	355	1,363
Alum	3,481	791	342	362	38	1,533
907 kkg/d						
Lime	4,350	957	132	684	781	2,555
Alum	5,511	1,260	472	800	68	2,600
1361 kkg/d						
Lime	5,572	1,226	158	1,027	1,166	3,578
Alum	6,984	1,602	560	1,198	95	3,455

TABLE A-8
(continued)

Subcategory and Mill Size	Capital ($1,000)	Amortized Capital ($1,000/yr)	Operation and Maintenance		Energy ($1,000/yr)	Total Annual ($1,000)
			Labor ($1,000/yr)	Chemicals ($1,000/yr)		
Semi-Chemical						
181 kkg/d						
Lime	1,366	301	81	114	141	638
Alum	1,927	434	225	130	19	808
386 kkg/d						
Lime	2,337	514	94	235	278	1,122
Alum	2,943	665	299	275	31	1,270
544 kkg/d						
Lime	2,833	623	103	339	390	1,456
Alum	3,581	813	341	388	39	1,581
Unbleached Kraft and Semi-Chemical						
634 kkg/d						
Lime	3,746	824	121	532	613	2,091
Alum	4,630	1,056	418	617	56	2,147
1361 kkg/d						
Lime	5,998	1,317	167	1,142	1,293	3,921
Alum	7,220	1,658	573	1,324	102	3,657
2359 kkg/d						
Lime	8,235	1,812	215	1,964	2,257	6,248
Alum	9,985	2,303	723	2,296	163	5,485
Dissolving Sulfite Pulp						
408 kkg/d						
Lime	3,750	825	117	450	645	2,037
Alum	8,835	2,033	661	1,869	137	4,700
544 kkg/d						
Lime	4,470	983	129	598	850	2,560
Alum	10,477	2,419	748	2,493	175	5,835
Papergrade Sulfite[2]						
91 kkg/d						
Lime	1,230	271	79	83	120	553
Alum	2,989	678	317	281	32	1,308
408 kkg/d						
Lime	3,270	719	108	355	500	1,682
Alum	7,151	1,646	584	1,278	100	3,608
907 kkg/d						
Lime	5,235	1,152	144	780	1,100	3,176
Alum	11,466	2,660	827	2,841	200	6,528

---

[1] Includes Fine Bleached Kraft and Soda subcategories

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories

Sludge from the clarifier is pumped to a sludge holding and mixing tank or directly to the lime mud dewatering system. After the lime mud has been dewatered to approximately 60 percent solids, it is transferred to a fluidized bed for drying and calcining. At this point, recovered lime is transferred back to the slaker for reuse in the color control process. Ninety percent recovery of lime was assumed.

In those cases where the total mill wastewater is treated using minimum lime coagulation, EPA assumed that the decolored wastewater would be further treated to lower the pH below the maximum allowable discharge (9.0). EPA assumed that sulfuric acid would be the chemical used for pH control. This pH adjustment system includes two neutralization tanks in series, each equipped with a mixer, and the chemical feed and storage equipment required for sulfuric acid addition.

Alum Coagulation - Alum coagulation is another available technology for removing color and can be applied to the total mill effluent for each of the subcategories from which highly-colored effluents are discharged. The costs for the alum coagulation system are based on the following items:

1. wastewater pumping,
2. sulfuric acid feed system,
3. chemically assisted clarification (solids contact clarifier),
4. chemical coagulation with alum (at a dosage appropriate for each subcategory) and polyelectrolyte addition (at 1 mg/l),
5. neutralization with 10 mg/l sodium hydroxide,
6. solids dewatering,
7. dissolved air flotation thickening,
8. chemical sludge transportation to landfill, and
9. chemical sludge landfill.

Normally, the topography of the effluent treatment site does not permit gravity flow through the entire treatment process. Thus, EPA assumed that it would be necessary to construct an effluent pumping facility that is capable of pumping the maximum daily flow to be treated.

The design assumes the use of a solids-contact clarifier to accomplish flocculation, settling, and sludge removal. For flows in excess of 18,900 cubic meters per day (5 MGD), EPA assumed the use of two parallel units, each capable of handling 50 percent of the daily flow.

At mills where activated sludge treatment is employed, the chemical clarification design reflects an additional solids-contact clarifier(s) following the existing secondary clarifier(s). It is likely that at many mills, an existing secondary clarifier(s) could be modified to allow for the addition of chemicals; this would result in significantly lower capital expenditure. An additional clarifier allows for the recycle of biological sludge that has not been contaminated by the addition of chemicals; this would allow for the addition of a chemical recovery system, if it were determined that such a system is economically advantageous.

The primary flocculant is alum at a dosage rate of 300 mg/l. Alum tends to lower the pH of the effluent. Optimum alum flocculation is reached at a pH of 4.0 to 6.0.(147)(148) Provision for the addition of sulfuric acid was included to optimize alum requirements. If the effluent pH changes to a value where the effectiveness of flocculation deteriorates and/or the effluent does not meet pH limitations, neutralization may be required. Therefore, EPA included neutralization with sodium hydroxide in the design.

Waste chemical solids from the secondary clarification process may require thickening before they can be effectively dewatered. If these solids were not thickened, the capacity of a dewatering unit would be greatly reduced. EPA selected air flotation as the specific thickening process in the development of costs. Air flotation requires that a flocculant, such as a polymer, is added to the waste solids prior to the thickening process.

Alum sludge is gelatinous and difficult to dewater. Mixing with primary sludge and/or the addition of polymer can improve dewaterability. The cost of dewatering of alum sludge was determined assuming the use of a separate horizontal belt filter press dewatering system to dewater chemical solids only. EPA assumed that dewatered sludge would be landfilled.

Ammonia Removal. EPA estimated the costs of ammonia removal at direct discharging mills where ammonia-based cooking chemicals are used. These costs were based on (a) substitution to a non-ammonia-based cooking liquor and (b) ammonia removal through biological nitrification. Model mill costs for direct dischargers are presented in Table A-9 for the semi-chemical, dissolving sulfite pulp, and papergrade sulfite subcategories.

Costs for substitution of chemical bases were developed based on installation of a new spent liquor recovery furnace and additional evaporation capacity to allow for a change from ammonia-based cooking to sodium-based cooking.(220) Increased evaporator capacity would be required to increase the solids content of the sodium-based spent liquor and to account for the increased tendancy for scaling (and subsequent need for more frequent washing). Spent sodium-based liquor has a lower heat value than spent ammonia-based liquor; EPA took this into account in its cost estimates. Another major cost item would be the increased cost of chemicals, with costs for NH_3 and Na_2CO_3

TABLE A-9

COSTS FOR AMMONIA REMOVAL FOR DIRECT DISCHARGERS

Subcategory	Mill Size (kkg/d)	Control[1]	Capital ($1,000)	Amortized Capital ($1,000/yr)	Operation and Maintenance ($1,000/yr)	Energy ($1,000/yr)	Total Annual ($1,000)
Semi-Chemical	181	I	1,500	331	52	137	520
		II	510	112	29	117	258
		III	850	186	39	71	296
		IV	277	61	18	51	130
		V	6,010	1,322	200	134	1,656
	386	I	2,857	628	71	291	990
		II	1,021	225	46	249	520
		III	1,586	349	52	150	551
		IV	528	116	28	108	252
		V	9,440	2,077	425	285	2,787
	544	I	3,846	846	81	411	1,338
		II	1,429	314	56	351	721
		III	2,079	457	58	212	727
		IV	733	161	34	152	347
		V	11,610	2,554	600	402	3,556
Dissolving Sulfite Pulp	408	I	12,640	2,780	161	889	3,830
		II	2,841	625	77	612	1,314
		III	5,429	1,194	115	92	1,401
		IV	700	154	0	0	154
		V	26,570	5,845	927	1,125	7,897
	544	I	16,181	3,560	181	1,185	4,926
		II	3,785	833	92	816	1,741
		III	6,886	1,515	129	123	1,767
		IV	930	205	0	0	205
		V	31,580	6,948	1,236	1,500	9,684
Papergrade Sulfite[2]	91	I	1,896	417	65	105	587
		II	369	81	24	85	190
		III	1,207	265	51	61	377
		IV	215	47	16	41	104
		V	7,450	1,639	179	220	2,038
	408	I	6,647	1,462	117	475	2,054
		II	1,575	347	59	384	790
		III	4,235	932	94	276	1,302
		IV	881	194	38	186	418
		V	18,370	4,041	806	990	5,837
	907	I	13,070	2,875	161	1,055	4,091
		II	3,498	769	94	854	1,717
		III	8,287	1,823	129	614	2,566
		IV	1,957	430	61	413	904
		V	29,650	6,523	1,790	2,200	10,513

---

[1] Control:

I - Modification of Activated Sludge at NSPS Option 1 (equal to BPT) raw waste loads
II - Modification of ASB at NSPS Option 1 (equal to BPT) raw waste loads
III - Modification of Activated Sludge at NSPS Option 2 raw waste loads
IV - Modification of ASB at NSPS Option 2 raw waste loads
V - Change chemical base and add recovery system

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories

reported at \$0.088/kg (\$0.04/lb), and \$0.154/kg (\$0.07/lb), respectively. At this cost penalty of \$0.066/kg (\$0.03/lb), an increased cost of \$5.50/kkg (\$5/ton) of pulp is realized. No cost credit was taken for the recovery or resale of chemicals.

EPA also developed costs for ammonia removal through the application of end-of-pipe treatment. EPA assumed that BPT effluent limitations are being met at existing mills through the use of the technology that formed the basis of BPT effluent limitations. The Agency also assumed that existing biological treatment systems would be converted to the extended aeration mode of activated sludge. Ammonia removal would be accomplished through single-stage nitrification. Nitrification is the process where specific bacteria convert ammonia to nitrite nitrogen and then to nitrate nitrogen (see Section VII). Conventional activated sludge systems and aerated stabilization basins can be converted to the extended aeration mode by system modification. Design criteria include a volumetric loading of 0.24 kg BOD_5/cu m/day (15 lb BOD_5/1000 ft^3/day), air requirements of 1.5 kg O_2/kg BOD_5 removed (1.5 lb O_2/lb BOD_5 removed) and 3.1 kg O_2/kg NH_3 removed (3.1 lb O_2/lb NH_3 removed), aeration capacity of 17 kg O_2/hp/day (37 lb O_2/hp/day), and a 48 hour aeration basin detention time. All other criteria are equivalent to those considered in estimating the cost of activated sludge systems in developing estimates of the cost of attainment of BPT effluent limitations.(48) The sludge ages for the modified biological treatment systems range from 24 to 37 days for the four subcategories of concern (dissolving sulfite pulp, semi-chemical, and both papergrade sulfite subcategories). They are two to five times greater than those cited in the literature (see Section VII).

Table A-9 presents the estimated costs to implement this end-of-pipe technology. The costs include an allowance for repositioning of existing aeration equipment in the aeration basin. Table A-9 also presents an estimate of costs assuming that conventional pollutant raw waste load reductions to NSPS Option 2 levels were implemented. These estimates assume no reduction in the ammonia raw waste load.

The sensitivity of the nitrification process to environmental conditions is well documented (see Section VII). Temperature, pH, and dissolved oxygen levels have interrelated effects on the ability of a biological treatment system to nitrify ammonia. The cost estimates in Table A-9 do not include provisions to heat or cool the effluent or to cover the aeration basin for temperature control.

COSTS FOR IMPLEMENTATION OF PSES AND PSNS

The toxic pollutants zinc, trichlorophenol, and pentachlorophenol can be controlled at new and existing indirect discharging mills through substitution of process chemicals. Slimicide and fungicide formulations containing chlorophenolics can be replaced by those that do not contain these compounds. Inquiries of chemical suppliers indicate that no definable cost differences will result from the application of this technology.

EPA estimated the cost of substitution of sodium hydrosulfite for zinc hydrosulfite at indirect discharging mills. These costs are presented in Table A-10.

COSTS FOR IMPLEMENTATION OF NSPS CONTROL AND TREATMENT OPTIONS

Conventional Pollutant Removal

Option 1. NSPS Option 1 for conventional pollutant control is based on the levels attained by best performing mills in each subcategory. Best mill performance for a subcategory is generally the average performance at all mills where BPT is attained using BPT technology (see Section VIII). End-of-pipe treatment is in the form of biological treatment for all subcategories except the nonintegrated-tissue papers, nonintegrated-filter and nonwoven papers, nonintegrated-lightweight papers, and nonintegrated-paperboard subcategories, where end-of-pipe treatment is in the form of chemically assisted primary clarification (at a dosage rate of 150 mg/l of alum). The design basis of this option is presented in Table A-11. Costs associated with implementation of this option are presented in Table A-12.

Option 2. This option involves the application of (a) production process controls to reduce wastewater discharge and raw waste loadings and (b) end-of-pipe treatment in the form of biological treatment for all subcategories except the nonintegrated-tissue papers, nonintegrated-filter and nonwoven papers, nonintegrated-lightweight papers, and nonintegrated-paperboard subcategories, where end-of-pipe treatment is in the form of chemically assisted primary clarification (at a dosage rate of 150 mg/l of alum). The design basis of NSPS Option 2 end-of-pipe treatment is the same as for NSPS Option 1. As discussed earlier, the implementation of production process controls can result in material and energy savings. EPA estimated the economic savings associated with the in-plant controls that form the basis of NSPS Option 2. These estimates are presented in Table A-13. Improved by-product recovery may also result; however, no estimates of savings resulting from by-product recovery were included in the figures presented in Table A-13. NSPS Option 2 model mill costs are presented in Table A-14.

Example calculations for the costs of NSPS Option 2 production process controls for a new alkaline-fine mill are presented in Table A-15. Tables A-16 and A-17 present example design parameters and cost calculations, respectively, for NSPS Option 2 end-of-pipe treatment for a new dissolving kraft mill.

Toxic Pollutant Removal

PCP, TCP, and zinc can be controlled at new sources through chemical substitution. Slimicide and biocide formulations containing chlorophenolics can be replaced with formulations that do not contain these toxic pollutants. Correspondence with chemical suppliers as to the relative cost of substitution to the use of process chemicals that

TABLE A-10

COSTS FOR SUBSTITUTING SODIUM HYDROSULFITE FOR ZINC HYDROSULFITE

Subcategory	Mill Size (kkg/d)	Sodium Hydrosulfite Used (kg/kkg)	Sodium Hydrosulfite Used (kkg/yr)	Cost Increase Due to Substitution ($1,000/yr)
PSES, PSNS (Indirect Dischargers - Existing and New)				
Groundwood-Thermo-Mechanical	272	1.0	95.2	37.8
Groundwood-CMN Papers	45	3.7	58.9	23.3
	544		712.5	279.1
	907		1,188.0	465.2
Groundwood-Fine Papers	68	6.7	160.8	63.4
	454		1,073.8	422.6
	680		1,608.3	633.8
NSPS (Direct Dischargers - New)				
Groundwood-Thermo-Mechanical	454	1.0	158.9	63.0
Groundwood-CMN Papers	454	3.7	594.6	232.6
Groundwood-Fine Papers	454	6.7	1,073.8	422.6

TABLE A-11

DESIGN BASIS
FOR ESTIMATES OF COSTS OF END-OF-PIPE TREATMENT FOR ATTAINMENT OF NSPS OPTIONS 1 AND 2

I. Integrated Segment and Deink and Nonintegrated-Fine Papers Subcategories

A. Primary Treatment

  1. Clarification at an overflow rate of 20 cu m/d/sq m

B. Activated Sludge Treatment

  1. Equalization with aeration

    a. 12 hr detention at peak flow

  2. Increase in aeration basin capacity with:

    a. Aeration design requirements of:
       1.5 kg O_2/kg BOD5
       11.2 kg O_2/aerator hp/d

    b. Detention at 1.5 times BPT levels
    c. Provisions for operation in a contact stabilization mode

  3. Clarification at an overflow rate of 16 cu m/d/sq m

  4. Solids handling system

II. All Other Secondary Fibers Subcategories(a)

A. Primary Treatment

  1. Clarification at an overflow rate of 24 cu m/d/sq m

B. Activated Sludge Treatment

  1. Equalization with aeration

    a. 12 hr detention at peak flow

  2. Aeration basin

    a. Volume at the larger of 0.8 kg BOD5 applied/cu m/d, or 8 hr hydraulic detection time
    b. Aeration design requirements of:
       1 kg O_2/kg BOD5
       19 kg O_2/aerator hp/d

  3. Clarification at an overflow rate of 20 cu m/d/sq m

  4. Solids handling system

III. All Other Nonintegrated Subcategories

A. Primary Treatment

  1. Chemically assisted clarification with 150 mg alum/l (flash mixing prior to clarifiers) at an overflow rate of 16 cu m/d/sq m

  2. Solids handling system

(a) End-of-pipe treatment system design for both NSPS Options 1 and 2 are based on the flow and BOD5 raw waste load that forms the basis of BPT effluent limitations.

TABLE A-12

COST SUMMARY FOR NSPS OPTION 1

Subcategory	Mill Size (kkg/d)	Capital ($1,000)	Operation and Maintenance and Energy ($1,000/yr)	Total Annual ($1,000)
Integrated Segment				
Dissolving Kraft	907	32,093	4,930	11,990
Market Bleached Kraft	680	20,388	2,403	6,889
BCT Bleached Kraft	454	17,992	1,918	5,876
Alkaline-Fine[1]	680	20,787	2,517	7,090
Unbleached Kraft				
o Linerboard	454	13,060	1,802	4,675
o Bag	907	20,247	2,825	7,280
Semi-Chemical	454	13,130	2,334	5,223
Unbleached Kraft and Semi-Chemical	1,361	26,709	3,762	9,638
Dissolving Sulfite Pulp				
o Nitration	454	30,429	6,059	12,753
o Viscose	454	31,721	6,366	13,344
o Cellophane	454	33,404	6,777	14,125
o Acetate	454	39,312	8,251	16,899
Papergrade Sulfite[2]	680	37,319	7,194	15,404
Groundwood-Thermo-Mechanical	454	12,219	1,636	4,324
Groundwood-CMN Papers	454	11,496	1,357	3,886
Groundwood-Fine Papers	454	11,248	1,363	3,838
Secondary Fibers Segment				
Deink				
o Fine Papers	454	17,131	3,027	6,796
o Tissue Papers	91	6,089	968	2,307
o Newsprint	454	17,131	3,027	6,796
	454	11,171	2,343	4,800
Tissue From Wastepaper	9	1,384	208	512

TABLE A-12
(continued)

Subcategory	Mill Size (kkg/d)	Capital ($1,000)	Operation and Maintenance and Energy[1] ($1,000/yr)	Total Annual ($1,000)
Secondary Fibers Segment (continued)				
Paperboard From Wastepaper				
o Noncorrugating Medium Furnish				
	91	2,465	299	842
	454	6,146	747	2,099
o Corrugating Medium Furnish				
	91	2,585	326	895
	454	6,528	842	2,279
Wastepaper-Molded Products	45	2,271	252	752
Builders' Paper and Roofing Felt	68	2,652	343	927
	136	3,929	492	1,356
Nonintegrated Segment				
Nonintegrated-Fine Papers				
o Wood Fiber Furnish	227	5,889	604	1,899
o Cotton Fiber Furnish	27	2,564	304	868
Nonintegrated-Tissue Papers	45	2,148	371	843
	227	5,711	912	2,169
Nonintegrated-Lightweight Papers				
o Lightweight	45	2,119	524	990
o Electrical	45	2,470	600	1,144
Nonintegrated-Filter and Nonwoven Papers	23	1,307	321	609
Nonintegrated-Paperboard	45	1,291	342	626

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE A-13

GROSS OPERATION AND MAINTENANCE AND ENERGY COSTS AND SAVINGS FOR NSPS OPTION 2 PRODUCTION PROCESS CONTROLS ($1,000/yr)

Subcategory	Mill Size (kkg/d)	Gross Operation and Maintenance[1]		Gross Energy	
		Cost	Savings	Cost	Savings
Integrated Segment					
Dissolving Kraft	907	230.7	524.3	691.0	80.6
Market Bleached Kraft	680	208.3	89.6	363.3	55.9
BCT Bleached Kraft	454	188.1	185.4	288.5	23.1
Alkaline-Fine[2]	680	263.7	120.2	309.3	82.9
Unbleached Kraft					
o Linerboard	454	120.0	176.5	109.3	119.2
o Bag	907	183.2	350.7	218.6	210.6
Semi-Chemical	454	151.4	137.2	204.5	80.4
Unbleached Kraft and Semi-Chemical	1,361	386.5	449.2	788.9	336.9
Dissolving Sulfite Pulp	454	922.7	776.3	1,237.4	116.9
Papergrade Sulfite[3]	680	1,130.1	1,172.7	1,517.0	253.6
Groundwood-Thermo-Mechanical	454	105.2	124.5	33.3	20.4
Groundwood-CMN Papers	454	48.3	38.0	40.3	150.8
Groundwood-Fine Papers	454	131.2	299.6	80.5	152.3
Secondary Fibers Segment					
Deink					
o Fine Papers	454	60.9	186.1	123.8	112.7
o Tissue Papers	91	35.8	37.2	29.4	41.8
	454	97.4	186.1	138.2	198.1
o Newsprint	454	60.9	186.1	123.8	112.7
Tissue From Wastepaper	9	9.3	1.8	4.8	2.2
Paperboard From Wastepaper	91	24.1	18.0	46.3	22.0
	454	50.6	90.0	231.7	110.0
Wastepaper-Molded Products	45	19.3	0.0	11.2	8.4
Builders' Paper and Roofing Felt	68	17.6	14.0	27.5	4.3
	136	25.8	27.9	55.1	8.6
Nonintegrated Segment					
Nonintegrated-Fine Papers					
o Wood Fiber Furnish	227	32.3	38.5	48.3	100.2
o Cotton Fiber Furnish	27	9.0	10.8	13.5	28.1
Nonintegrated-Tissue Papers	45	9.7	15.8	7.0	8.0
	227	26.0	78.7	33.8	18.6
Nonintegrated-Lightweight Papers	45	29.8	19.0	16.5	16.7
Nonintegrated-Filter and Nonwoven Papers	23	20.2	4.6	7.8	11.2
Nonintegrated-Paperboard	45	13.0	6.4	5.3	6.2

---

[1] Excludes energy costs.

[2] Includes Fine Bleached Kraft and Soda subcategories.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE A-14

COST SUMMARY FOR NSPS OPTION 2

Subcategory	Mill Size (kkg/d)	Capital ($1,000)	Operation and Maintenance ($1,000/yr)	Energy ($1,000/yr)	Total Annual ($1,000)
Integrated Segment					
Dissolving Kraft	907	33,102	3,371	1,865	12,518
Market Bleached Kraft	680	21,834	1,742	829	7,375
BCT Bleached Kraft	454	17,699	1,439	665	5,998
Alkaline-Fine[1]	680	20,233	1,983	687	7,121
Unbleached Kraft					
o Linerboard	454	8,635	738	146	2,784
o Bag	907	14,057	1,145	298	4,536
Semi-Chemical	454	9,138	689	306	3,005
Unbleached Kraft and Semi-Chemical	1,361	22,250	1,554	968	7,417
Dissolving Sulfite Pulp					
o Nitration	454	37,905	2,369	2,048	12,756
o Viscose	454	38,049	2,386	2,064	12,821
o Cellophane	454	39,239	2,520	2,208	13,361
o Acetate	454	42,994	2,947	2,672	15,077
Papergrade Sulfite[2]	680	41,705	2,503	2,195	13,873
Groundwood-Thermo-Mechanical	454	10,329	1,029	246	3,547
Groundwood-CMN Papers	454	9,485	1,073	185	3,345
Groundwood-Fine Papers	454	11,382	1,071	167	3,742
Secondary Fibers Segment					
Deink					
o Fine Papers	454	11,536	2,260	247	5,045
o Tissue Papers	91	5,191	816	79	2,037
	454	14,055	2,393	346	5,830
o Newsprint	454	11,171	2,185	158	4,800
Tissue From Wastepaper	9	1,384	196	12	512
Paperboard From Wastepaper					
o Noncorrugating Medium Furnish	91	2,465	299[3]		842
	454	6,146	747[3]		2,099
o Corrugating Medium Furnish	91	2,585	326[3]		895
	454	6,528	842[3]		2,279
Wastepaper-Molded Products	45	2,271	233	19	752
Builders' Paper and Roofing Felt	68	2,652	301	42	927
	136	3,929	415	77	1,356

TABLE A-14
(continued)

Subcategory	Mill Size (kkg/d)	Capital ($1,000)	Operation and Maintenance ($1,000/yr)	Energy ($1,000/yr)	Total Annual ($1,000)
Nonintegrated Segment					
Nonintegrated-Fine Papers					
o Wood Fiber Furnish	227	4,339	504	42	1,500
o Cotton Fiber Furnish	27	2,129	261	18	747
Nonintegrated-Tissue Papers	45	1,647	354	8	724
	227	4,077	835	49	1,781
Nonintegrated-Lightweight Papers					
o Lightweight	45	2,711	492	14	1,102
o Electrical	45	3,081	565	19	1,262
Nonintegrated-Filter and Nonwoven Papers	23	1,698	310	7	690
Nonintegrated-Paperboard	45	1,616	341	7	704

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

[3] Separate operation and maintenance and energy costs for the Paperboard From Wastepaper subcategory are not presented. These estimates include updated "pre-BPT" internal control costs presented in the Phase I BPT Development Document which reported operation and maintenance and energy costs as a single figure. (46)

TABLE A-15

NSPS OPTION 2 PRODUCTION PROCESS CONTROLS
SAMPLE COST CALCULATIONS
680 kkg/d Alkaline-Fine Mill

A. Capital

Item No.	Item	Cost
1	Dry Operation of Woodroom	$1,433,300
2	Disposal of Digester Blow Condensates	24,200
3	Addition of Fourth Stage Brown Stock Washer	838,000
4	Spill Collection for Pulp Mill Brown Stock	300,000
5	Full Countercurrent Washing in Bleachery	2,731,000
6	Boil Out Tank for Evaporators	46,400
7	Spill Collection in Liquor Preparation Area	349,000
8	Segregation of Cooling Water in Utility Area	69,700
9	Boiler Blowdown and Backwash Lagoon	124,800
10	pH Monitors on Sewers	8,000
		$5,924,400

B. Energy Requirements

Item No.	Item	Increase in Electricity Use (kwh/kkg)	Reduction or Increase in Steam Use (kg/kkg)
1	Dry Operation of Woodroom	--	(48.7)
2	Disposal of Digester Blow Condensates	1.22	--
3	Addition of Fourth Stage Brown Stock Washer	7.70	--
4	Spill Collection for Pulp Mill Brown Stock	2.48	--
5	Full Countercurrent Washing in Bleachery	2.15	(33.6)
6	Boil Out Tank for Evaporators	0.46	--
7	Spill collection in Liquor Preparation Area	1.55	(4.8)
8	Segregation of Cooling Water in Utility Area	0.33	(20.8)
9	Boiler Blowdown and Backwash Lagoon	0.46	--
10	pH Monitors on Sewers	--	--
		16.35	(107.9)

	Cost
Cost of Electric Power = \$0.0325/kwh x 16.35 kwh/kkg =	\$ 0.53/kkg
Steam Saving = 107.9 kg/kkg x 2425 Btu/kg x \$1.24/10^6Btu =	- 0.32/kkg
Net Increase in Cost of Energy =	\$ 0.21/kkg

C. Annual Cost-Example

3	Addition of Fourth Stage Brown Stock Washer	Cost
	Fixed Cost = 22% of \$838,000	\$ 184,360
	Maintenance = 4.5% of capital	37,710
	Added Labor	0
	Electric Power = 233 kw x 24 hr/d x 352 d/yr x \$0.0325/kwh	63,972
		\$ 286,042

TABLE A-16

DESIGN PARAMETERS FOR NSPS OPTION 2
EXAMPLE CALCULATION

907 kkg/d Dissolving Kraft Mill

Raw Waste:

Flow = 211.6 kl/kkg
BOD5 = 58.4 kg/kkg
TSS = 113.0 kg/kkg

Design Parameters:

Flow:
907 kkg/d x 211.6 kl/kkg x 1 cu m/kl = 191,000 cu m/d

BOD5 Removed (assume 15 percent of BOD5 is removed in primary system; therefore, 85 percent of BOD5 applied will be removed by biological system):
907 kkg/d x 0.85 x 58.4 kg BOD5/kkg = 45,000 kg BOD5/d

Basin Volumes (assume 0.8 kg BOD5/cu m):
Stabilization = 907 kkg/d x 58.4 kg BOD5/kkg x 1.25 cu m/kg BOD5 = 66,200 cu m
Contact = one-half stabilization = 0.5 x 66,200 cu m = 33,100 cu m

Aeration (assume 11.2 kg BOD5/d/HP):
907 kkg/d x 58.4 kg BOD5/kkg x 0.0893 HP/kg BOD5 = 4,730 HP

Solids Production:
Primary (assume 75 percent of raw waste TSS applied is removed):
0.75 x 907 kg/d x 113.0 kg TSS/kkg = 76,900 kg/d
Biological (assume additional 10 percent of raw waste TSS is removed and 32 percent of BOD5 applied becomes solids):
907 kkg/d x [(0.10 x 113.0 kg TSS/kkg) + (0.32 x 58.4 kg BOD5/kkg)]
= 27,200 kg/d

TABLE A-17

COST SUMMARY FOR NSPS OPTION 2 UNIT PROCESS END-OF-PIPE TREATMENT EXAMPLE CALCULATION

907 kkg/d Dissolving Kraft Mill

Treatment	Capital ($1,000)	Amortized Capital ($1,000/yr)	Operation and Maintenance ($1,000/yr)	Energy ($1,000/yr)	Total Annual ($1,000)
Flow Equalization with Aeration (peaking factor = 1.3)	1,591	350	19	66	435
Wastewater Pumping (peaking factor = 1.3)	1,744	384	25	112	520
Preliminary Treatment	328	72	27	0	99
Primary Settling	3,969	873	51	5	929
Acid Neutralization	55	12	22	10	44
Alkaline Neutralization	55	12	22	10	44
NaOH For Biological Treatment	0	0	223	0	223
Stabilization Basin	3,061	673	94	0	768
Contact Basin	1,758	387	71	0	458
Aeration	3,312	729	0	946	1,675
Secondary Clarification	6,427	1,314	74	38	1,525
Flow Monitoring	43	10	63	0	73
Outfall	23	5	0	0	5
Diffuser	414	91	0	0	91
Foam Collection Tank	92	20	0	0	20
Nutrient Addition	0	0	417	0	417
Flotation Polymer	0	0	218	0	218
Flotation Thickening	1,552	342	61	55	458
Dewatering Polymer	0	0	828	0	828
Horizontal Belt-Filter	2,218	488	91	13	592
Primary and Biological Sludge Transportation	0	0	789	0	789
Primary and Biological Sludge Landfill	1,202	264	274	0	539
Subtotal	27,843	6,125	3,371	1,255	10,751

do not contain these toxic pollutants indicate that no definable cost difference will result from the implementation of this control technology.

Zinc can be controlled at new source groundwood mills by replacing zinc hydrosulfite, a bleaching chemical, with sodium hydrosulfite. The costs of this substitution at new sources in the three groundwood subcategories are presented in Table A-10.

ENERGY AND NON-WATER QUALITY IMPACTS

Energy Requirements

EPA anticipates that the implementation of some of the various control and treatment options considered as the basis of final rules could affect existing energy demand. Estimates of the energy requirements of each specific technology option are presented in this section. In some cases, the implementation of production process controls may result in a net energy saving. It is possible that, even where a net energy saving is achieved in terms of net heat energy, energy costs can increase because of the relative amounts of fuels and electricity used and their respective prices.

EPA determined total energy usage prior to implementation of the various technology options (baseline energy usage) based on data contained in the API monthly energy reports. Average power and fuel usages were determined from information obtained as a result of the data request program. An energy balance was developed for each model mill; the balance takes into account the energy of spent liquor and hogged fuel, if appropriate.

Table A-18 summarizes the estimate of total energy used at direct discharging mills. Total energy is presented in heat energy units (Btu). In order to properly account for energy requirements, EPA converted electrical energy (kwh) to heat energy (Btu) at a conversion of 10,500 Btu/kwh, which reflects the average efficiency of electrical power generation.

BPT. EPA estimates that attainment of BPT in the wastepaper-molded products subcategory will require the use of the equivalent of approximately 604 thousand liters (3.8 thousand barrels) of residual fuel oil per year, a 0.0017 percent increase in estimated current industry energy usage and a 1.8 percent increase in current energy usage at mills in the wastepaper-molded products subcategory. For the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategory and the cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory, in-place technology or current permit conditions are such that EPA anticipates that no incremental energy usage will result from implementation of BPT effluent limitations.

TABLE A-18

TOTAL ENERGY USAGE AT EXISTING DIRECT DISCHARGING MILLS
(10^9 Btu/yr)

Subcategory	Baseline[1]
Integrated Segment	
Dissolving Kraft	50,538
Market Bleached Kraft	68,856
BCT Bleached Kraft	87,326
Alkaline-Fine[2]	128,775
Unbleached Kraft	
o Linerboard	139,382
o Bag	86,048
Semi-Chemical	51,786
Unbleached Kraft and Semi-Chemical	124,954
Dissolving Sulfite Pulp	40,529
Papergrade Sulfite[3]	56,305
Groundwood-Thermo-Mechanical	3,628
Groundwood-CMN Papers	9,061
Groundwood-Fine Papers	17,301
Integrated-Miscellaneous	454,353
Secondary Fibers Segment	
Deink	
o Fine Papers	3,486
o Tissue Papers	8,715
Tissue From Wastepaper	2,634
Paperboard From Wastepaper	30,725
Wastepaper-Molded Products	1,345
Builders' Paper and Roofing Felt	1,705
Secondary Fibers-Miscellaneous	7,425
Nonintegrated Segment	
Nonintegrated-Fine Papers	27,947
Nonintegrated-Tissue Papers	7,639
Nonintegrated-Lightweight Papers	6,777
Nonintegrated-Filter and Nonwoven Papers	796
Nonintegrated-Paperboard	1,362
Nonintegrated-Miscellaneous	6,066
Total	1,425,464
Residual Fuel Oil (10^6 barrels/yr)	227

---

[1] Baseline energy use is based on data contained in API monthly energy reports.

[2] Includes Fine Bleached Kraft and Soda subcategories.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

BAT. Because the technology basis of BAT effluent limitations is chemical substitution, implementation of BAT will not result in any increase in energy usage at existing direct discharging mills.

EPA estimates that implementation of chloroform removal technology at the nine mills where closed biological treatment systems are employed would increase the energy used to operate wastewater treatment systems by over 70 percent.

If color were regulated based on the technologies discussed in Section VIII, energy usage would increase at existing direct discharging mills. Table A-19 presents the Agency's estimate of the total energy increase that would result from implementation of color removal technology at all direct discharging mills where highly-colored effluents are discharged. EPA estimates that the energy increase over current total energy usage at these mills would be equivalent to about 2.5 percent for minimum lime coagulation and 0.5 percent for alum coagulation.

Establishment of ammonia limits at the eight mills where ammonia-based cooking chemicals are employed might mean that the equivalent of 78 million liters (489 thousand barrels) and 44 million liters (277 thousand barrels) of residual fuel oil per year, respectively, would be required through conversion to a different chemical base or modification of existing biological treatment to operate in a nitrification mode (assuming that raw waste loads are identical to those that formed the basis of BPT limitations). This represents 6.2 and 3.5 percent, respectively, of current energy usage at these eight mills.

NSPS. Table A-20 presents an estimate of energy usage at new source direct discharging mills for the base case (attainment of BPT effluent limitations) and for NSPS Options 1 and 2. In order to properly account for energy requirements of each alternative, EPA converted electrical energy (kwh) to heat energy (Btu) at a conversion of 10,500 Btu/kwh, which reflects the average efficiency of electrical power generation.

Pretreatment Standards. Because the technology basis of PSES and PSNS is chemical substitution, implementation of PSES and PSNS will not increase energy usage at indirect discharging mills.

Air Pollution

None of the technology options considered for BPT, BAT, NSPS, PSES, or PSNS are expected to result in significant increases in air pollution. The technologies that form the bases of BAT effluent limitations and pretreatment standards do not generate air emissions. Operation of biological and primary treatment systems to comply with BPT effluent limitations and NSPS will not generally increase air emissions to any significant extent.

TABLE A-19

ADDITIONAL ENERGY USAGE AT EXISTING DIRECT DISCHARGING MILLS WITH THE IMPLEMENTATION OF COLOR REMOVAL TECHNOLOGY

(10^9 Btu/yr)

Subcategory	Baseline	Lime	Alum
Integrated Segment			
Dissolving Kraft	50,538	1,312	262
Market Bleached Kraft	68,856	1,348	385
BCT Bleached Kraft	87,326	1,533	378
Alkaline-Fine[1]	128,775	2,439	548
Unbleached Kraft			
o Linerboard	139,382	3,708	323
o Bag	86,048	2,289	199
Semi-Chemical	51,786	1,595	178
Unbleached Kraft and Semi-Chemical	124,954	3,828	1,066
Dissolving Sulfite Pulp	40,529	1,354	279
Papergrade Sulfite[2]	56,305	1,810	362
Integrated-Miscellaneous	413,779	8,994	1,922
Total	1,248,278	30,210	5,902
Residual Fuel Oil (10^6 barrels/yr)	198	5	0.9

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE A-20
ENERGY USAGE AT NEW SOURCE DIRECT DISCHARGING MILLS

Subcategory	Mill Size (kkg/d)	Energy Usage (10^9 Btu/yr) Baseline[1]	NSPS Option 1	NSPS Option 2
Integrated Segment				
Dissolving Kraft	907	14,886	456	603
Market Bleached Kraft	680	8,178	209	268
BCT Bleached Kraft	454	6,163	141	215
Alkaline-Fine[2]	680	9,303	182	222
Unbleached Kraft				
o Linerboard	454	4,876	62	47
o Bag	907	9,752	120	96
Semi-Chemical	454	4,050	82	99
Unbleached Kraft and Semi-Chemical	1,361	10,364	198	313
Dissolving Sulfite Pulp	454	6,824	431	726
Papergrade Sulfite[2]	680	9,696	443	369
Groundwood-Thermo-Mechanical	454	4,134	130	709
Groundwood-CMN Papers	454	5,316	73	60
Groundwood-Fine Papers	454	4,968	69	54
Secondary Fibers Segment				
Deink				
o Fine Papers	454	3,176	154	80
o Tissue Papers	91	635	34	26
	454	3,176	154	112
o Newsprint	454	3,079	51	51
Tissue From Wastepaper	9	45	4	4
Paperboard From Wastepaper				
o Noncorrugating Medium Furnish	91	623	17	17
	454	3,115	84	84
o Corrugating Medium Furnish	91	625	19	19
	454	3,126	95	95
Wastepaper-Molded Products	45	237	6	6
Builders' Paper and Roofing Felt	136	785	25	25
Nonintegrated Segment				
Nonintegrated-Fine Papers				
o Wood Fiber Furnish	227	1,010	19	14
o Cotton Fiber Furnish	27	122	7	6
Nonintegrated-Tissue Papers	45	415	3	3
	227	2,075	12	16
Nonintegrated-Lightweight Papers				
o Lightweight	45	572	5	5
o Electrical	45	572	7	6
Nonintegrated-Filter and Nonwoven Papers	23	240	3	2
Nonintegrated-Paperboard	45	409	2	2

---

[1] Baseline energy use is based on data contained in API monthly energy reports and BPT Development Documents.

[2] Includes Fine Bleached Kraft and Soda subcategories.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

Most of the NSPS production process controls identified in NSPS Option 2 are expected to have little direct impact on air emissions. However, if additional steam is required, some increase in sulfur dioxide generation could occur. Such an increase would be directly proportional to the increased boiler firing rate and the sulfur content of the fuel used. This situation is not unique to the pulp, paper, and paperboard industry, but exists for all industrial categories. Air pollution control techniques are available to minimize such increases.

Production process controls that help retain more spent liquor in the liquor recovery cycle include improved brown stock washing, decker filtrate reuse, use of blow condensates, neutralization of spent sulfite liquor before evaporation, and more complete use of evaporator condensates. These controls tend to retain more sulfur-containing compounds in the liquor system. As sulfur levels increase along with increased total liquor solids to recovery, emissions can increase. With modern recovery systems of adequate capacity, emission levels of mercaptans, hydrogen sulfide, and other compounds to the atmosphere would not increase beyond allowable limits. Generally, the normal variations in firing rates, sulfidity, and liquor solids overshadow the effects resulting from implementation of the production process controls considered.

Noise Potential

There is no identifiable potential for substantially increased noise associated with any of the control and treatment technology options considered. Existing effluent treatment processes are not a significant source of noise.

Solid Waste Generation

General. A study by Energy Resources Company quantified the various solid wastes generated in 1977 in the pulp, paper, and paperboard industry.(221) In addition to sludge generated as a result of wastewater treatment, other types of solid waste generated by this industry include chemical ash, pulping wastes, and wood wastes.

The kraft and sulfite processes produce the majority of chemical pulping wastes, consisting of green liquor dregs, lime wastes (slaker rejects and unburned rejects from lime kilns), and cooking chemical recovery process wastes. Green liquor dregs are normally sewered and, therefore, are likely to be included in wastewater sludge estimates. Lime wastes and recovery wastes (normally oxides of the cooking chemical base from the sulfite process) were estimated to be 535,000 metric tons (589,000 tons) in 1977.(221)

About 2,700,000 metric tons (3,000,000 tons) of landfilled bark and wood waste and approximately 1,000,000 metric tons (1,100,000 tons) of coal ash were generated in 1977.(221)

Miscellaneous pulp, paper, and paperboard industry solid waste included 1,700,000 metric tons (1,900,000 tons) of wastepaper reclamation waste (i.e., strapping, dirt, metal, and ink) in 1977.(221) Other wastes include evaporator residue and tall oil residue; these are generated in insignificant quantities when compared to other solid wastes. Total 1977 process solid waste excluding wastewater treatment sludge was about 5,900,000 metric tons (6,500,000 tons).

In a 1974 study, it was estimated that pulp, paper, and paperboard industry personnel generated about 0.23 kg (0.5 lb) of refuse per employee per shift, resulting in a total annual industry generation rate of 16,600 metric tons (18,300 tons).(48) This source of solid waste is insignificant when compared to process-related sources.

Wastewater treatment facilities produce both primary and biological sludges that are usually dewatered prior to disposal. The amount of wastewater treatment sludge generated depends on a number of conditions including: (a) raw waste characteristics, (b) the existence, efficiency, and/or type of primary treatment, (c) the type of biological treatment system employed, and (d) the efficiency of biological solids removal from the wastewater. EPA estimated the amount of primary and biological sludges generated at direct discharging mills in each subcategory. These estimates were based on sludge production criteria outlined in Section VII and are shown in Table A-21.

Toxic Pollutant Control. Chemical substitution, the technology basis of BAT, PSES, PSNS, and NSPS toxic pollutant control options will not result in any increase in solid waste generation. Additionally, implementation of chloroform removal technology at the nine mills where closed systems are employed would not increase solid waste generation at these mills.

Conventional Pollutant Control. Attainment of BPT in the wastepaper-molded products subcategory may generate an additional 100 kkg/yr (110 tons/yr) of solid waste. This is equal to 0.0042 percent of current wastewater treatment solids generated in the industry and 20 percent of the current wastewater solids generated in the wastepaper-molded products subcategory.

For the nonintegrated-lightweight papers, nonintegrated-filter and nonwoven papers, and nonintegrated-paperboard subcategories and the cotton fiber furnish subdivision of the nonintegrated-fine papers subcategory, in-place technology or current permit conditions are such that EPA anticipates that no incremental solid waste generation will result from implementation of BPT effluent limitations.

Table A-22 presents an estimate of the solid waste generation at new source direct discharging mills for the base case (attainment of BPT effluent limitations) and for NSPS Options 1 and 2.

TABLE A-21

TOTAL WASTEWATER SOLID WASTE GENERATION AT EXISTING DIRECT DISCHARGING MILLS (1,000 kkg/yr, dry solids)

Subcategory	Baseline[1]	
	Primary	Biological
Integrated Segment		
Dissolving Kraft	91.0	35.3
Market Bleached Kraft	65.2	32.6
BCT Bleached Kraft	112.6	43.0
Alkaline-Fine[2]	199.1	65.0
Unbleached Kraft		
o Linerboard	81.6	35.7
o Bag	50.4	22.0
Semi-Chemical	23.4	22.6
Unbleached Kraft and Semi-Chemical	71.7	36.5
Dissolving Sulfite Pulp	68.7	65.0
Papergrade Sulfite[3]	118.3	64.8
Groundwood-Thermo-Mechanical	6.6	3.4
Groundwood-CMN Papers	19.2	5.2
Groundwood-Fine Papers	38.9	9.9
Integrated-Miscellaneous	543.2	213.5
Secondary Fibers Segment		
Deink		
o Fine Papers	26.7	5.7
o Tissue Papers	66.7	14.0
Tissue from Wastepaper	10.2	1.5
Paperboard from Wastepaper	17.4	5.6
Wastepaper-Molded Products	0.5	0.1
Builders' Paper and Roofing Felt	3.3	0.7
Secondary Fibers-Miscellaneous	17.6	3.7
Nonintegrated Segment		
Nonintegrated-Fine Papers	34.4	6.5
Nonintegrated-Tissue Papers	10.9	0
Nonintegrated-Lightweight Papers	8.1	0
Nonintegrated-Filter and Nonwoven Papers	0.5	0
Nonintegrated-Paperboard	1.5	0
Nonintegrated-Miscellaneous	7.8	0.5
Total	1,695.5	692.8

---

[1] Baseline wastewater solid waste production is based on estimated BPT raw waste loads; baseline solid waste other than wastewater solids is 6,016,600 kkg/yr.

[2] Includes Fine Bleached Kraft and Soda subcategories.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

TABLE A-22
WASTEWATER SOLID WASTE GENERATION AT NEW SOURCE DIRECT DISCHARGING MILLS

Subcategory	Mill Size (kkg/d)	Wastewater Solid Waste Generation (1,000 kkg/yr) Baseline[1]	NSPS Option 1	NSPS Option 2
Integrated Segment				
Dissolving Kraft	907	37.9	38.8	37.1
Market Bleached Kraft	680	11.9	12.7	11.2
BCT Bleached Kraft	454	11.2	11.6	11.0
Alkaline-Fine[2]	680	17.9	18.7	17.4
Unbleached Kraft				
o Linerboard	454	4.0	4.2	3.8
o Bag	907	8.0	8.3	7.5
Semi-Chemical	454	3.0	3.4	2.7
Unbleached Kraft and Semi-Chemical	1,361	11.8	12.4	11.3
Dissolving Sulfite Pulp	454	22.6	23.9	17.7
Papergrade Sulfite[3]	680	27.2	28.2	24.7
Groundwood-Thermo-Mechanical	454	7.7	8.0	6.8
Groundwood-CMN Papers	454	7.9	8.2	7.8
Groundwood-Fine Papers	454	8.4	8.7	8.2
Secondary Fibers Segment				
Deink				
o Fine Papers	454	29.9	30.4	28.6
o Tissue Papers	91	6.0	6.1	5.8
	454	29.9	30.3	29.2
o Newsprint	454	29.9	28.1	28.1
Tissue From Wastepaper	9	0.28	0.28	0.28
Paperboard From Wastepaper				
o Noncorrugating Furnish	91	0.34	0.35	0.35
	454	1.7	2.0	2.0
o Corrugating Furnish	91	0.40	0.43	0.43
	454	2.0	2.1	2.1
Wastepaper-Molded Products	45	0.22	0.21	0.21
Builders' Paper and Roofing Felt	136	1.5	1.4	1.4
Nonintegrated Segment				
Nonintegrated-Fine Papers				
o Wood Fiber Furnish	227	2.3	2.5	2.3
o Cotton Fiber Furnish	27	0.51	0.54	0.49
Nonintegrated-Tissue Papers	45	0.43	0.55	0.53
	227	2.1	2.7	2.7
Nonintegrated-Lightweight Papers				
o Lightweight	45	0.66	0.95	0.92
o Electrical	45	0.66	1.0	0.99
Nonintegrated-Filter and Nonwoven Papers	23	0.13	0.22	0.21
Nonintegrated-Paperboard	45	0.27	0.41	0.41

---

[1] Baseline wastewater solid waste generation is based on estimated BPT raw waste loads.

[2] Includes Fine Bleached Kraft and Soda subcategories.

[3] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

Nonconventional Pollutants. If color were regulated based on the technologies discussed in Section VIII, solid waste generation would increase at existing direct discharging mills. Table A-23 presents the Agency's estimate of the total increase in solid waste that would result from implementation of color removal technology at all direct discharging mills where highly-colored effluents are discharged.

EPA estimates that implementation of ammonia removal technology (conversion to a different chemical base or modification of existing biological treatment to operate in a nitrification mode) would not result in any measurable increase in solid waste generation.

Disposal Methods. Acceptable techniques for solid waste disposal include incineration, composting, pyrolysis - gasification, and landfill. McKeown reported that, in 1975, about 10 percent of wastewater sludges were incinerated and about 85 percent were disposed of by land application.(222) Incineration is a preferred method for disposal of organic wastes with low moisture contents such as log sorting and mill yard wastes.

Composting is an emerging technology that theoretically could be applied to pulp, paper, and paperboard mill wastewater treatment sludges. Through proper composting, sludge can be converted to non-pathogenic organic material that may be used as a soil conditioner.

Pyrolysis-gasification may play a future role in solid waste disposal. Commercial-scale units from which economic effectiveness has been proven or operating experience obtained have yet to be utilized.

Land application of wastewater treatment plant sludges is a viable disposal option. Sludge can be applied to a field that will be used for agricultural production. The organics, nutrients, and sludge bulk can serve to enhance crop production capacity. A prerequisite for the technique is that adequate and suitable land is available within a reasonable proximity of the plant.

Landfills are the most prevalent means of solid waste disposal in the industry. The primary environmental problem associated with landfill disposal of wastewater sludges is the potential for leachate contamination of ground and surface waters.

Environmental safety procedures and knowledge of proper landfilling practices have increased widely in recent years. The EPA has established operating and design criteria for several landfill techniques for sludges ranging from 20 to 30 percent solids.(216) These techniques include a) area fill layer, b) area fill mound, c) diked containment, d) narrow trench, e) wide trench, f) co-disposal with soil, and g) co-disposal with refuse. The cited reference describes required site and operating conditions for each method.

TABLE A-23

ADDITIONAL WASTEWATER SOLID WASTE GENERATION AT DIRECT DISCHARGING MILLS WITH THE IMPLEMENTATION OF COLOR REMOVAL TECHNOLOGY

(1,000 kkg/yr)

Subcategory	Baseline	Lime	Alum
Integrated Segment			
Dissolving Kraft	126.3	36.0	31.6
Market Bleached Kraft	97.8	35.7	37.0
BCT Bleached Kraft	155.6	41.6	41.3
Alkaline-Fine[1]	264.1	65.3	62.5
Unbleached Kraft			
o Linerboard	117.3	98.5	29.4
o Bag	72.4	60.8	18.2
Semi-Chemical	46.0	40.2	11.0
Unbleached Kraft and Semi-Chemical	108.2	102.7	29.1
Dissolving Sulfite Pulp	133.7	35.8	28.7
Papergrade Sulfite[2]	183.1	49.6	38.7
Integrated-Miscellaneous	549.7	241.4	164.6
Total	1854.2	807.6	492.1

---

[1] Includes Fine Bleached Kraft and Soda subcategories.

[2] Includes Papergrade Sulfite (Blow Pit Wash) and Papergrade Sulfite (Drum Wash) subcategories.

Implementation Requirements

Availability of Equipment. EPA expects that present manufacturing capabilities are such that required equipment can be readily produced. Any increased demand for either production process control equipment or wastewater treatment equipment should be met without major delays. No geographical limitations are anticipated because of the ability of this industry to use local independent contractors for fabrication of certain pieces of equipment.

Availability of Labor Force. Manpower necessary for implementation of technology alternatives could come from two sources: a) mill personnel and b) outside contractors. On jobs that cannot be completed during a normal shut-down or are considered too complex for mill personnel, an outside contractor can be hired to perform the necessary tasks.

A Bureau of Labor Statistics study concluded that the availability of construction laborers to perform the required work is sufficient.(223) This availability is based on two major factors. This first factor is the short training time that is required for construction labor (6 to 12 months). The second factor is the willingness of construction labor to relocate. Therefore, availability of labor is not anticipated to be a problem in implementing the technology alternatives.

Implementation Time. For end-of-pipe treatment facilities, normal construction techniques and crews would be required. The bar graph presented in Figure A-1 shows the estimated time required to implement the BPT and NSPS technologies.

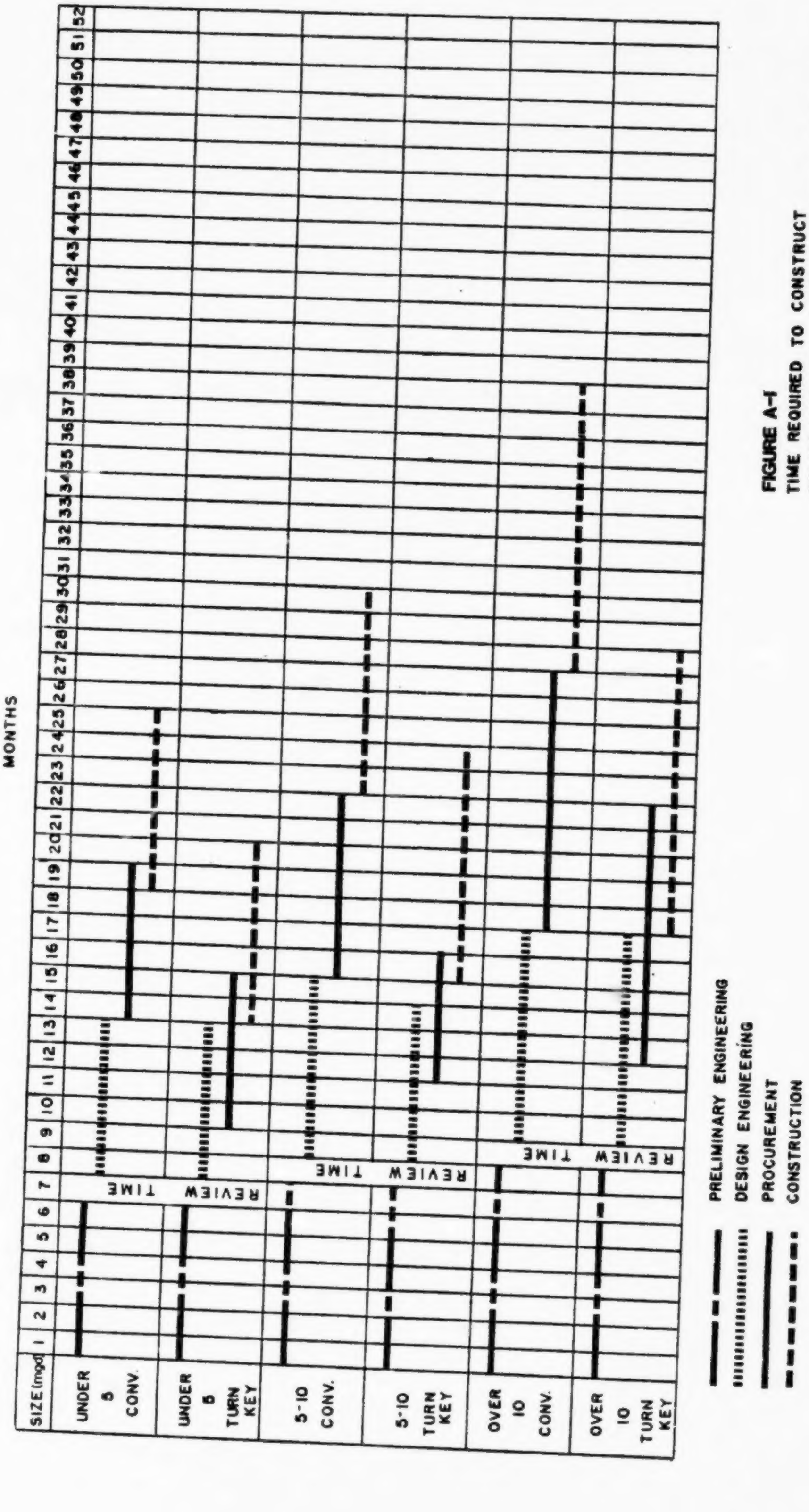


FIGURE A-1
TIME REQUIRED TO CONSTRUCT
SOLIDS CONTACT CLARIFIER/BIOLOGICAL SYSTEM

APPENDIX B

GLOSSARY

Abaca - Manila fiber, or manila hemp, obtained from the leafstalk of a variety of plantain or banana, native to the Philippine Islands. Its principal usage is marine cordage, but is also used for rope, papers, and tea bags.

Active Alkali - A measure of the strength of alkaline pulping liquor indicating the sum of caustic soda and sodium sulfide expressed as Na_2O.

Activated Sludge Process - A high rate biological oxidation process. The significant feature of the process is the recycle of a biologically-active sludge formed by settling the microorganism population from the aeration process in a clarifier. Waste is treated in a matter of hours rather than days.

Aeration - The process of being supplied or impregnated with air. Aeration is used in biological treatment to dissolve oxygen in the wastewater. This dissolved oxygen is required by microorganisms as they feed on organic matter in the wastewater.

Air Dry Ton (ADT) - Measurement of production including a moisture content of 10 percent by weight.

Alkali - $NaOH + Na_2O$, expressed as Na_2O in alkaline cooking liquors.

Alpha-cellulose - The true cellulose content of a fibrous material.

Available Chlorine - The oxidizing power of a bleaching agent expressed in terms of elemental chlorine.

Bagasse - Crushed stalks of sugarcane after the sugar has been removed.

Bag Paper - Paper used in making grocery bags or sacks.

Bale - A standard bale of wastepaper is 72 in. long, 32 in. wide, and 28 in. deep, with a content of about 37 cubic feet and weighing 900 to 1,000 lbs. The size and weight may vary with the grade of paper. A bale of pulp varies in weight from 400 to 500 lbs and is approximately 30x30x13 in. in size. A bale of rags varies in weight from 700 to 1,300 lbs and will vary in dimensions according to the press used. Typical dimensions are 26x30x72 in., 26x42x72 in., or 26x52x54 in. A bale of bags weighs 61 to 62 lbs.

Barometric Leg - A pipe drawing water from a decker or similar piece of equipment discharging below the surface of the water in a receiving tank. A syphon action is created thus drawing a vacuum on the decker.

Barker - A piece of equipment designed to remove the bark from a log.

Barking - The operation of removing bark from pulpwood prior to processing. This is carried out by means of a knife, drum, mechanical abrasion, hydraulic barker, or by chemical means.

Basis Weight - The weight of a sheet of paper of a given area. It is effected by the density and thickness of the sheet.

Beater - A machine consisting of a tank or "tub," usually with a partition or "midfeather," and containing a heavy roll revolving against a bedplate. Both roll and bedplate may contain horizontal metal bars set on edge. Pulp or wastepapers are put into the tub of the beater and water is added so that the mass may circulate and pass between the roll and the bedplate. This action separates the material and frees the fibers preparatory to further processing. Fillers, dyestuffs, and sizing materials may be added to the beater and thus incorporated with the paper stock. Many modifications in design have been developed without changing the basic principles. See also Refiner.

Biological Oxidation - The process by which bacterial and other microorganisms oxidize complex organic materials to simpler compounds and use these for growth and energy. Self-purification of waterways and biological waste treatment systems such as activated sludge, trickling filter and aerated stabilization depend on this principle.

Black Liquor - The used cooking liquor recovered from the digester. It may also be referred to as spent cooking liquor. Strong black liquor refers to the liquor after it has been concentrated by an evaporator to a level suitable for combustion. Prior to evaporation, it is referred to as weak black liquor.

Bleaching - The brightening and delignification of pulp by the addition of oxidizing chemicals such as chlorine or reducing chemicals such as sodium hypochlorite.

Blow - Ejection of the chips from a digester, or waste solids from a boiler.

Blowdown - The liquid and solid waste materials ejected from a pressure vessel such as a boiler.

Blow Pit - A large tank under a digester which receives the discharged chips and liquor from the digester. A constructed stainless steel plate within the blow pit acts to break up the chip structure into individual fibers of pulp upon impact.

Biochemical Oxygen Demand (BOD5) - Quantity of dissolved oxygen utilized in the biochemical oxidation of organic matter in a specified time (5 days) and at a specified temperature. It is not related to the oxygen requirements in chemical combustion, being determined entirely by the biodegradability of the material and by the amount of oxygen utilized by the microorganisms during oxidation.

Boil-out - A procedure, usually utilizing heat and chemicals, to clean equipment such as evaporators, heat-exchangers, and pipelines.

Bone Dry - See Oven Dry.

Break - A term used to denote a complete rupture of a web of paper or paperboard during manufacture or some subsequent operation which utilizes rolls of paper.

Breaker Stack - Two rolls, one above the other, placed in the dryer section of a papermachine to compact the sheet and smooth out its surface defects.

Breast Roll - A large diameter roll around which the Fourdrinier wire passes at the machine headbox, just at or ahead of the point where the stock is admitted to the wire by the stock inlet. The roll is covered with corrosion-resistant metal or fiberglass and is usually driven by the Fourdrinier wire.

Brightness - As commonly used in the paper industry, the reflectivity of a sheet of pulp, paper, or paperboard for specified light measured under standardized conditions.

Brightness Unit - An increment of measurement to assess the brightness of paper.

Bristol - Paper characterized by its cardlike features.

Broke - Partly or completely manufactured paper that does not leave the machine room as salable paper or paperboard; also paper damaged in finishing operations such as rewinding rolls, cutting, and trimming.

Brown Stock - Pulp, usually kraft or groundwood, not yet bleached or treated other than in the pulping process.

Calcium Hypochlorite - A chemical commonly used in the paper industry for bleaching pulp, and in water treatment as a germicide.

Calender Stack - Two or more adjacent and revolving rolls which provide even thickness control of the sheet and the final finishing of its surface.

Capacity - Production of a unit, usually in tons per day.

Causticizing - Process of making white liquor from green liquor by addition of slaked lime. Most Na_2CO_3 is thereby converted to NaOH.

Cellulose - The major polysaccharide component of the cell walls of all woods, straws, bast fibers and seed hairs. It is the main solid constituent of wood plants and is the principal raw material of pulp, paper and paperboard.

Central Limit Theorem - A statistical theorem. If any random variable X may be represented as a sum of any N independent random variables, then in general, the sum X, for large N, is approximately normally distributed. The importance of the theorem is that the mean x of a random sample from any distribution is approximately normal with mean μ and variance τ^2/N if the sample size is large.

Chemical Oxygen Demand (COD) - A measure of the oxygen-consuming capacity of organic and inorganic matter present in water or wastewater. It is expressed as the amount of oxygen consumed from a chemical oxidant in a specific test.

Chemical Wood Pulp - Pulp obtained by digestion of wood with solutions of various chemicals. The principal chemical processes are the sulfite, sulfate (kraft), and soda processes.

Chest (or Stock Chest) - A tank used for storage of wet fiber or furnish.

Chipper - A machine consisting essentially of a revolving disk equipped with heavy radially-arranged knives, which cuts pulpwood and sawmill waste into slices or chips, diagonal to the grain.

Chips - Small pieces of wood used to make pulp.

Chlorine Dioxide - A chemical ClO_2 used in pulp bleaching as a water solution, usually in one or more of the latter stages of a multistage sequence. It is prepared by a variety of processes at the plant site usually from sodium chlorate, acid, and a reducing agent.

Chromophoric - Relating to color in a molecule, that can be attributed to the presence of a chemical group or groups.

Clarifier - In wastewater treatment, a settling tank which removes solids from wastewater through gravitational settling. The settled material, called sludge, is removed from the tank bottom by a rake arm.

Clay - In general, a natural, earthy, fine-grained material which develops plasticity when wetted, but is hard when baked or fired. Used as filler and for coating paper sheets.

Cleaner - A device which creates a cyclone effect to remove dirt and other rejects from pulp using the differences in density to aid in separation.

Coarse Papers - Paper used for grocery and shopping bags, sacks, and special industrial papers.

Coated - A term applied to paper and paperboard, whose surface has been treated with clay or some other pigment and adhesive mixture or other suitable material, to improve the finish with respect to printing quality, color, smoothness, opacity, or other surface properties. The term is also applied to lacquered and varnished papers.

Color - Refers to standard APHA Platinum Cobalt Test, using standards for color intensity of water samples. Commonly, standards are prepared at various concentrations which later may be referenced as units of color, derived from flow and concentration standard.

Color Plant - The portion of a fine papermill where pulp is dyed or colored prior to being made into paper.

Color Unit - A measure of color concentration in water using NCASI methods.

Composite Sample - A mixture of grab samples collected at the same sampling point at different times.

Confidence Level (or Confidence Interval) - An interval about a sample quantity which is likely to contain the population value, with some specified assurance.

Consistency - The percentage, by weight, of air dry (or oven dry) fibrous material in a stock or stock suspension. It is also called density or concentration.

Converting - Any operation in which paper is made into a product, not necessarily the final product to be made.

Cooking - Heating of wood, water, and chemicals in a closed vessel under pressure to a temperature sufficient to separate the fibrous portion of wood by dissolving lignin and other nonfibrous constituents.

Cooking Liquor - The mixture of chemicals and water used to dissolve lignin in wood chips.

Corrugating Medium - A paperboard used at corrugating plants to form the corrugated or fluted (wave-like) member in making such products as corrugated combined board and corrugated wrapping materials.

Cotton Linters - Short fibers surrounding the cotton seed.

Couch Pit - A pit or catch basin located under the couch roll on a fourdrinier machine to receive water removed at the couch or wet broke in case of a wet end break.

Couch Roll - This term refers to a roll primarily involved in dewatering and picking off, or couching, of the newly formed paper web from the wire on which it was formed and partially dewatered. The couch roll is involved in the transfer of the web to the wet press felt for further dewatering.

Countercurrent Washing - Refers to a method of washing used on the bleach plant or brownstock washers where fresh water is applied on the last stage showers, and the effluent from each stage is used on the washer showers of the preceding stage.

Creped - A light crinkled characteristic imparted to paper by a creping device to increase surface area, absorption, and elasticity. This is a customary procedure in tissue papers and fine decorative papers.

Cylinder Machine - One of the principal types of papermaking machines, characterized by the use of wire-covered cylinders or molds on which a web is formed.

Debarking - See "Barking".

Decker - A piece of equipment commonly used to thicken pulp. It consists of a wire-covered drum in a pulp vat. A vacuum is applied to the center of the drum, commonly by a barometric leg, to pull water out of the stock slurry.

Deflaker - A high-speed mixing and agitating machine through which a fibrous stock suspension in water is pumped to obtain complete separation and dispersion of each individual fiber, and break up of any fiber lumps, knots, or bits of undefibered paper.

Deinking - The operation of reclaiming fiber from waste paper by removing ink, coloring materials, and fillers.

Density - Weight per unit volume.

Diffusion Washing - Washing pulps with an open ended vessel by diffusing or passing the wash media through the pulp mass.

Digester - The vessel used to treat pulpwood, straw, rags or other such cellulosic materials with chemicals to produce pulp.

Disk Refiner - A motor-driven refiner whose working elements consist of one or more matched pairs of disks having a pattern of ribs machined into their faces and arranged so that one disk of the pair is rotated. The other disk is usually stationary, but may be driven in the opposite direction of rotation.

Dissolved Oxygen - Amount of oxygen, expressed in milligrams per liter, dissolved in water.

Dissolved Solids - The total amount of dissolved material, organic and inorganic, contained in water or wastes.

Dissolving Pulp - A special grade of chemical pulp made from wood or cotton linters for use in the manufacture of regenerated cellulose (viscose rayon and cellophane) or cellulose derivatives such as acetate and nitrate.

Doctor Blade - A thin plate or scraper of wood, metal, or other hard substance placed along the entire length of a roll or cylinder to keep it free from the paper, pulp, or size, thus maintaining a smooth, clean surface.

Dregs - The inert rejects from the green liquor clarifier of a pulp mill.

Dregs Washer - A piece of equipment used to wash the green liquor (Na_2CO_3) off the dregs prior to their disposal.

Dry End - The mill term for the drying section of the papermachine, consisting mainly of the driers, calenders, reels, and slitters.

Esparto - A grass whose bast fibers are used to produce high-class book and printing papers and medium class writing papers.

Evaporators - Process equipment used to concentrate spent pulping liquors prior to burning.

Extended Aeration - A modification of the activated sludge process that employs aeration periods of 18 hours or more.

Extraction Water - Water removed during a pulp manufacturing process.

Fatty Acid - A naturally-occuring organic compound of wood.

Felt - The endless belt of wood or plastic used to convey and dewater the sheet during the papermaking process.

Fiber - The cellulosic portion of the tree used to make pulp, paper, and paperboard.

Filler - A material, generally nonfibrous, added to the fiber furnish of paper. In paperboard manufacturing, the inner ply or plies of a multiple layer product.

Fine Papers - Papers for printing, reproduction and writing.

Fines - Very short pulp fibers or fiber fragments and ray cells. They are sometimes referred to as flour or wood flour.

Finishing - The various operations in the manufacture and packaging of paper performed after it leaves the papermachine. Finishing operations include supercalendering, plating, slitting, rewinding, sheeting, trimming, sorting, counting, and packaging. Ruling, punching, pasting, folding, and embossing are also sometimes considered as finishing operations.

Flour - A term applied to the fine fibers or fiber fragments of a pulp. They are also known as fines.

Flume - A sloped trough with flowing water used to transfer pulpwood from one point to another.

Fourdrinier Machine - A papermaking machine employed in the manufacture of all grades of paper and paperboard. It may be divided into four sections, the wet end, the press section, the drier section, and the calender section.

Freeness - A measure of the rate with which water drains from a stock suspension through a wire mesh screen or a perforated plate. It is also known as slowness or wetness.

Furnish - The mixture of fibers and chemicals used to manufacture paper.

Gland - A device utilizing a soft wear-resistant material used to minimize leakage between a rotating shaft and the stationary portion of a vessel such as a pump.

Gland Water - Water used to lubricate a gland. Sometimes called "packing water".

Glassine Paper - Paper used as protective wrapping of foodstuffs and products including tobacco products, chemicals, metal parts, as well as for purposes where its transparent features are useful (i.e., window envelopes). This paper is grease resistant and has high resistance to the passage of air and many essential oil vapors.

Gloss - The property of a surface which causes it to reflect light specularly and is responsible for its shiny or mirror-like appearance.

Grab Sample - A sample collected at a particular time and place.

Grade - The type of pulp or paper product manufactured.

Greaseproof Paper - Paper used when resistance to oil and grease penetration is necessary.

Green Liquor - Liquor made by dissolving the smelt from the kraft process water and weak liquor preparatory to causticizing.

Green Liquor Clarifier - A piece of equipment used to separate the dregs from the green liquor, allowing recovery of the green liquor for processing into white "cooking" liquor.

Grinder - A machine for producing mechanical wood pulp or groundwood. It is essentially a rotating pulpstone against which logs are pressed and reduced to pulp.

Grindstone - A natural or artifical stone which is channeled or grooved and used for the manufacture of mechanical, chemi-mechanical, and groundwood pulp.

Groundwood Papers - A general term applied to a variety of papers, other than standard newsprint, made with substantial proportions of mechanical wood pulp together with chemical wood pulps, and used mainly for printing and converting purposes.

Hardwood - A term applied to wood obtained from trees of the angiosperm class, such as birch, gum, maple, oak, and poplar. Hardwoods are also known as porous woods.

Headbox - The area of the papermachine that uniformly spreads and distributes the dilute stock suspension and from which the stock flows through a sluice onto the wire.

Hemicellulose - The secondary component of cell walls of wood consisting primarily of short-chained (low molecular weight) polysaccharides.

Hemp - A tall plant native to Asia having stems that yield a coarse fiber used in the cordage and textile industry. Enters the paper industry as old cordage or rough textile waste.

Hot Ponds - Heated ponds of water used to thaw frozen logs.

Impregnation - The process of treating a sheet or web of paper or paperboard with a liquid such as hot asphalt or wax, a solution of some material in a volatile solvent, or a liquid such as an oil. It is also used as a term to describe a treatment in which fibrous raw materials are infused with a chemical solution prior to a digesting or fiberizing process. Sometimes called pre-impregnation.

Integrated - A term used to describe a pulp and paper mill operation in which all or some of the pulp is processed into paper at the mill.

Jordan - A refiner whose working elements consist of a conical plug rotating in a matching conical shell. The outside of the plug and the inside of the shell are furnished with knives or bars commonly called tackle.

Jumpstage Countercurrent Washing - Another type of countercurrent washing in which fresh water is used on the last two stages and filtrates from the acid stages are used on the preceding acid stage with the filtrate from the final alkaline stage being used on the preceding alkaline stage.

Jute - The glossy fiber of either of two East Indian plants of the linden family used chiefly for sackling burlap and twine. In papermaking, cuttings from burlap manufacture, washed sugarbagging and wool tares used in wrapping cotton bales are used as raw material sources.

Kappa Numbers - The permanganate number of a pulp measured under controlled conditions and corrected to be the equivalent of 50 percent consumption of the permanganate solution in contact with the specimen. It gives the degree of delignification of pulp through a wider range than does the older permanganate number test.

Kiln - A furnace or oven used in the pulp and paper industry to burn lime and calcium carbonate to produce CaO, which is used again with green liquor to form white liquor.

Knots - An imperfection in paper or lumps in paper stock resulting from: 1) incompletely defibered textile materials; the term applies especially to rag paper manufacture; 2) small undefibered clusters of wood pulp; and 3) the basal portion of a branch or limb which has become incorporated in the body of the tree.

Knotter - A mechanical device, usually a screen, for removing knots from wood pulp.

Kolmogorov - Smirnov Goodness of Fit Test - A nonparametric statistical test of goodness of fit for an observed continuous frequency distribution to the expected frequency distribution representing the hypothesis.

Kraft - A descriptive term for the (alkaline) sulfate pulping process, the resulting pulp, and paper or paperboard made therefrom.

Lap - See Wet Lap.

Lignin - A non-degradable organic compound of wood which is removed during pulping.

Lime Mud - A solid residue generated from the white liquor clarifier in the lime recovery/white liquor preparation process.

Linerboard - A paperboard made on a Fourdrinier or cylinder machine and used as the facing material in the production of corrugated and solid fiber shipping containers.

Market Pulp - A pulp manufactured explicitly for purchase.

Mathieson Process - A process of producing chlorine dioxide, using SO_2 as a reducing agent.

Mechanical Pulp - Pulp produced by physical means without the use of chemicals or heat, often referred to as groundwood.

Metering Rod - A rod used to apply coating to the surface of a sheet, metering even thickness coating layers on the surface.

Molded Pulp Products - Contoured products, such as egg packaging items, food trays, plates, and bottle protectors, made by depositing fibers from a pulp slurry onto a forming mold of the contour and shape desired in the product.

Mud Filter - A piece of equipment used to thicken and wash lime mud prior to burning it in the lime kiln.

Mud Washer - A piece of equipment used to wash the sodium base chemicals from the lime mud prior to burning it in the lime kiln.

Newsprint - Paper, made largely from groundwood pulp with a small percentage of chemical pulp added for strength, used chiefly in the printing of newspapers.

Nip - The point at which two adjacent rolls come together.

Nonparametic Methods - Statistical methods which do not require the assumption of a distributional form, such as a normal distribution.

Nonwood Fibers - Fibers not of the wood family used to produce pulp, paper, and paperboard. Such as vegetable fibers (cotton, flax, jute, hemp, cereal straw, bagasse, bamboo, esparto, abaca, sisal, pineapple), animal fiber (wool), mineral fiber (asbestos, glass), and man-made or artifical fiber (rayon, nylon, orlon, dacron).

Normal Distribution - A statistical distribution identified by a bell shaped curve which is the most important of all continuous distributions. This distribution curve is symetrical about the mean.

Nutrients - Elements, or compounds, essential as raw materials for organism growth and development (as in activated sludge process).

Opacity - A measure of the index of transparency of paper, by measuring the quantity of light that is transmitted through the paper sheet.

Oven Dry - A pulp or paper which has been dried to a constant weight at a temperature of 100° to 105°C (212° to 221°F).

Oxidation Pond - A low-rate biological process in which biological treatment takes place in a man-made pond. Dissolved oxygen is supplied by natural aeration processes such as wind, algae, photosynthesis, and partial pressure.

Paperboard - One of the two broad subdivisions of paper products. Paperboard is heavier in basis weight, thicker, and more rigid than paper. In general, all sheets 12 points (0.012 in.) or more in thickness are classified as paperboard. There are a number of exceptions based upon traditional nomenclature. For example, blotting paper, felts, and drawing paper in excess of 12 points are classified as paper while corrugating medium, chipboard, and linerboard less than 12 points are classified as paperboard. Paperboard is made from a wide variety of furnishes on a number of types of machines, principally cylinder and fourdrinier. The broad classes are: 1) container board, which is used for corrugated cartons; 2) boxboard which is further divided into, a) folding boxboard, b) special food board, and c) setup boxboard; and 3) all other special types such as automobile board, and building board.

Parametric Methods - Classical statistical methods which are effective for samples taken from normally distributed populations.

Permanganate Number (K NO.) - This method (T-214-TAPPI Std.) is used to determine the relative "hardness" or bleach requirements of pulp. By definition, it is the number of milliliters of 0.1 N potassium permanganate solution absorbed by 1 gram of moisture-free pulp under specified control conditions.

Peroxide - A chemical used in bleaching of wood pulps, usually groundwood pulps.

Porosity - A measure of time required for 100 cm^3 of air to flow through a sample area. Also termed "air resistance" (in seconds per 100 cm^3).

Precipitators - Equipment used to remove ash and other fine solids from gases exiting the boilers and furnaces in a mill.

Precook - Prehydrolysis.

Prehydrolysis - Pre-steaming of chips in the digester prior to cooking; usually associated with improved bleaching of kraft pulps.

Press - In a papermachine, a pair of rolls between which the paper web is passed for one of the following reasons: 1) water removal at the wet press; 2) smoothing and leveling of the sheet surface at the smoothing press; and 3) application of surface treatments to the sheet at the size press.

Printability - The ability of a paper surface to accept printing ink.

pth Percentile - A real number which divides the area under a probability density function corresponding to a continuous distribution into two parts of specified amounts (i.e., 99th percentile divides the density function into one percent and 99 percent of the population).

Pulp - Cellulosic fibers after conversion from wood chips.

Pulper - A mechanical device used to separate fiber bundles in the presence of water prior to papermaking.

Pulping - The operation of reducing a cellulosic raw material, such as pulpwood, rags, straw, and reclaimed paper into a pulp suitable for papermaking.

Pulpwood - Those woods which are suitable for the manufacture of chemical or mechanical wood pulp. The wood may be in the form of logs as they come from the forest or cut into shorter lengths suitable for the chipper or the grinder.

Rag Paper - A paper product manufactured by use of such materials as cotton or linen threads, flax and hemp, raw cotton, and other textile fibers and cotton linters, as well as rags.

Recovery Furnace or Recovery Boiler - A boiler which burns the strong black liquor.

Red Stock - Sulfite pulp after the pulping process, prior to other treatments, such as bleaching.

Reel - 1) A term applied to the untrimmed roll of paper of full machine width wound on a large shaft at the dry end of the papermachine. 2) The shaft on which the paper is first wound when it leaves the driers. 3) A term for the operation of winding paper into a reel.

Refiner - A machine used to rub, macerate, bruise, and cut fibrous material, usually cellulose, in water suspension to convert the raw fiber into a form suitable for formation into a web of desired characteristics on a papermachine. See also Deflaker, Disk Refiner, Jordan.

Refining - A general term applied to several operations, all of which involve the mechanical treatment of pulp in a water suspension to develop the necessary papermaking properties of the fibers and to cut the fibers to the desired length distribution. See Refiner.

Rejects - Material unsuitable for pulp or papermaking which has been separated in the manufacturing process.

Repulping - The operation of rewetting and fiberizing pulp or paper for subsequent sheet formation. See also Pulper.

Resin - A special additive used to produce wet-strength in paper or board.

Resin Acid - A naturally occuring organic compound in wood.

Rewinder - The term rewinder is often used for the winder in the finishing room, distinguishing it from the winder which follows the slitter at the end of the papermachine.

Rewinding - The operation of winding the paper accumulated on the reel of papermachine onto a core to give a tightly wound roll suitable for shipping or for use in the finishing or converting department.

Rosin - A brittle yellow or amber-colored natural resin that is obtained from southern pine, (types: gum rosin, wood rosin, and tall-oil rosin). Used in papermaking for internal (beater) sizing of paper.

Roundwood - Logs as received in the woodyard. The logs can be any length and usually have not been debarked.

R-2 Process - A modification of the Mathieson process.

Saltcake Loss - The loss of cooking chemical from the kraft cycle, primarily at the brownstock washers or screen room.

Sample Mean - The average of a population calculated from the sample; it is the most commonly used measure of the center of a distribution. Its value equals the sum of the values of the observations divided by the number of observations.

Saveall - A mechanical device used to recover papermaking fibers and other suspended solids from a wastewater or process stream.

Screening - 1) The operation of passing chips over screens to remove sawdust, slivers and oversize chips. 2) The operation of passing pulp or paper stock through a screen to reject coarse fibers, slivers, shives, and knots.

Screw Press - A device used to recover spent liquor from cooked chips.

Scrubbers - Equipment for removing noxious gases from the exhaust of certain areas in the mill, such as the bleachery or washers.

Sheet - A term used extensively in the paper industry meaning: 1) A single piece of pulp, paper, or paperboard; 2) the continuous web of paper as it is being manufactured; 3) a general term for a paper or paperboard in any form and in any quantity which, when used with appropriate modifying words, indicates with varying degrees of specificity, attributes of the product such as quality, class, use, grade, or physical properties (Examples: a bright sheet, a kraft sheet, a folding boxboard sheet); and 4) to cut paper or paperboard into sheets of desired size from roll or web.

Shive - A bundle of incompletely separated fibers which may appear in the finished sheet as an imperfection.

Side-Hill Screens - Steeply sloped screens usually used to remove some water from suspensions of stock or other solids while retaining the solid on the screen surface.

Size - Any material used in the internal sizing or surface sizing of paper and paperboard. Typical agents are rosin, glue and gelatin, starch, modified celluloses, synthetic resins, latices, and waxes.

Size Press - A unit of a paper machine, usually located between two drier sections, used to apply, meter and distribute evenly size onto paper.

Sizing - 1) Relates to a property of paper resulting from an alteration of fiber surface characteristics. In terms of internal sizing, it is a measure of the resistance to the penetration of water and various liquids. In terms of surface sizing, it relates to the increase of such properties as water resistance, abrasion resistance, abrasiveness, creasibility, finish, smoothness, surface bonding strength, printability, and the decrease of porosity and surface fuzz. 2) The addition of materials to a papermaking furnish or the application of materials to the surface of paper and paperboard to provide resistance to liquid penetration and, in the case of surface sizing, to affect one or more of the properties listed in 1).

Slaker - A device used to regenerate white liquor in the green liquor recovery process.

Slasher - A saw or set of saws used to cut long logs to desired length.

Slitter - A set of knives used to slit a reel of paper into the desired widths as the reel is rewound.

Sludge - Semi-fluid mixture of fine solid particles with a liquid. May contain fibrous and filler materials, and/or biological solids.

Slurry - A suspension of solid particles in a liquid.

Smelt - The molten inorganic cooking chemicals from the recovery boiler.

Soda Process - The first process for the manufacture of chemical wood pulp. Involves boiling wood in caustic alkali at a high temperature.

Softwood - Coniferous woods, such as pines, spruces, and hemlocks.

Solvay Process - A modification of the Mathieson process.

Spent Cooking Liquor - Cooking liquor after digestion containing lignaceous, as well as chemical, materials.

Stock - 1) Pulp which has been beaten and refined, treated with sizing, color, filler, etc. and which, after dilution, is ready to be formed into a sheet of paper. 2) Wet pulp of any type at any stage in the manufacturing process. 3) Paper in inventory or in storage. 4) Paper or other material to be printed, especially the paper for a particular piece of work. 5) A term used to describe a paper suitable for an indicated use, such as coating raw stock, milk carton stock, tag stock, and towel stock.

Stock Preparation - A term for the several operations which occur between pulping (or bleaching) and formation of the web on a papermachine. It may include, for example, repulping, beating, refining, and cleaning.

Stone - See Grindstone.

Sulfidity - Sulfidity is a measure of the amount of sulfur in kraft cooking liquor. It is the percentage ratio of NaS, expressed as NaO, to active alkali.

Thickener - A device using vacuum or gravity type suction mesh screen to remove excess water from pulp.

Tolerance Level - Provides an interval within which at least a proportion of the population lies with probability $1-\alpha$ or more (i.e, 99 percent of the observations lie below a given value with 70 percent confidence).

Unbleached - A term applied to paper or pulp which has not been treated with bleaching agents.

Vegetable Parchment - A wet strength paper product used as wrapping for moist materials.

Virgin Wood Pulp - Pulp made from wood, as contrasted to wastepaper sources of fiber.

Viscosity - The resistance to flow in a liquid; a measurement used in stock preparation as an indicator of pulp condition.

Washer - A piece of equipment, usually either a decker or side hill screen type, equipped with showers to wash chemicals from pulp stock or reject solids.

Wastepaper - A general term used to specify various recognized grades such as No. 1 news, new kraft corrugated cuttings, old corrugated containers, manila tabulating cards, coated soft white shavings, etc., which are used as a principal ingredient in the manufacture of certain types of paperboard, particularly boxboard made on cylinder machines where the lower grades may go into filler stock, and the higher grades into one or both liners.

Web - The sheet of paper coming from the papermachine in its full width or from a roll of paper in any converting operation.

Wet End - That portion of the papermachine between the headbox and the drier section. See Fourdrinier Machine.

Wet Lap Machine - A machine used to form pulp into thick rough sheets sufficiently dry to permit handling and folding into bundles (laps) convenient for storage or transportation.

Wet Laps - Rolls or sheets of pulp of 30 to 45 percent consistency to facilitate transportation of market pulp, and prepared in a process similar to papermaking.

Wet Press - The dewatering unit used on a papermachine between the sheet-forming equipment and the drier section.

Wet Strength - The strength of paper after complete saturation with water.

Wet Strength Additives - Chemicals such as urea and melanine formaldehydes used in papermaking to impart strength to papers used in wet applications.

White Liquor - The name applied to liquor made by causticizing green liquor.

White Water - A general term for all papermill waters which have been separated from the stock or pulp suspension, either on the papermachine or accessory equipment, such as thickeners, washers, and savealls, and also from pulp grinders.

Winder - The machine which winds into rolls, the paper coming from the papermachine reel.

Wire - An endless moving belt made of metal or plastic, resembling a window screen, upon which a sheet of paper is formed on a Fourdrinier machine.

Wire Pit - A pit under the wire of a Fourdrinier machine, which receives some of the water drained or pulled out of the paper sheet.

Wood Flour - Finely ground wood or fine sawdust used chiefly as a filler.

Wood Preparation - A series of operations utilized to prepare wood to a suitable state for further development into pulp, paper, and paperboard. These operations include barking, washing, and chipping.

Woodroom - The area of a pulp mill that handles the barking, washing, chipping or grinding of logs, and processing of purchased chips.

Woodyard - The area of a mill where roundwood is received and stored prior to transport to the woodroom.

Yankee Machine - A papermachine using one large steam-heated drying cylinder for drying the sheet, instead of many smaller ones. Commonly used for manufacturing tissue.

Yield - In pulp and papermaking, the ratio of product to raw material.

APPENDIX C

LEGEND OF ABBREVIATIONS

A: Acid or Dechlorination

AA: Atomic Adsorption

ADT: Air Dry Tons

APHA: American Public Health Association

API: American Paper Institute

ASB: Aerated Stabilization Basin

ATM: Atmospheres

Avg: Average

Ba: Barometric

BAT: Best Available Technology Economically Achievable

BCT: Best Conventional Pollutant Control Technology

BCT Bleached Kraft: Paperboard, Coarse, and Tissue Bleached Kraft

BlK: Bleached Kraft

BMP: Best Management Practices

BOD$_5$: Biochemical Oxygen Demand (five day)

BP: Blow Pit Wash

BPT: Best Practicable Control Technology Currently Available

Brd: Board or Paperboard

BS: Bisulfite

Btu: British thermal units

C: Chlorination Stage (bleach)

°C: Degrees Centigrade

Ca: Calcium

CAC: Chemically Assisted Clarification

CaO: Calcium Oxide

CFR: Code of Federal Regulations

Chg: Change

CMN: Coarse, Molded, Newsprint

CMP: Chemi-Mechanical Pulp

COD: Chemical Oxygen Demand

Cont: Contained

Conv: Converting

Corrug: Corrugating

Ctd: Coated

cu ft: cubic feet

cu m: cubic meter

cu m/day: cubic meter per day

d: day

D: Chlorine Dioxide Stage (bleach)

DAF: Dissolved Air Flotation

Dens: Density

DI: Deinked

Diss: Dissolving

DMR: Discharge Monitoring Report

DO: Dissolved Oxygen

DR: Drum Wash

E: Extraction Stage (caustic bleach)

E. Coli.: Escherichia Coliform

EC/GC: Electron Capture Detection/Gas Chromatography

EFF: Effluent

ENR: Engineering News Record

EPA: U.S. Environmental Protection Agency

Est: Estimate

Excl: Excluding

F: Fine

fps: feet per second

°F: degrees Fahrenheit

ft: feet

ft^3: cubic feet

FW: Fresh Water

Fwp: From wastepaper

GAC: Granular Activated Carbon

gal: gallons

GC/MS: Gas Chromatography/Mass Spectrometry

gpd/sq ft: gallons per day per square foot

gpm: gallons per minute

GWD: Groundwood

GW. Spec.: Groundwood Specialties

H: Hypochlorite stage (bleach)

ha: hectare

hp: horsepower

hr: hour

HS: Hydrosulfite (bleach)

HW: Hardwood

H_2O_2: Hydrogen peroxide

HWK: Hardwood Kraft

Ind: Industrial

Inf: Influent

Insul: Insulation

JTU: Jackson Turbidity Unit

K: Kraft

$K_{.99}$: 99th Percentile of a Population

kg: kilogram, 1000 grams

kg/ha: kilograms per hectare

kg/kkg: kilograms per 1000 kilograms

kg/sq cm: kilograms per square centimeter

kgal: 1000 gallons

kgal/ton or kgal/t: 1000 gallons per ton

kkg: 1000 kilograms (metric ton)

kkg/day: 1000 kilograms/day

kl/kkg: kiloliters per thousand kilograms

kw: kilowatt

kwh: kilowatt hour

l: liter

lb: pound

lb/ac/day: pound per acre per day

lb/gal: pound per gallon

lb/t: pounds per ton

log: logarithm

mach: machine

MD: Maximum Day Limit

mg: million gallons

mgd: million gallons per day

mg/l: milligrams per liter

MgO: Magnesium Oxide

min: minute

misc: miscellaneous

mkt: market

ml: milliliter

MLSS: Mixed Liquor Suspended Solids

MLVSS: Mixed Liquor Volatile Suspended Solids

MST: Median Survival Time

M30DA: Maximum 30 Day Average Limit

n: Number of daily observations

N.A.: Not Available or Not Applicable

Na: Sodium

Na_2CO_3: Sodium Carbonate (Soda Ash)

$NaOH$: Caustic Soda (Sodium Hydroxide)

Na_2S: Sodium Sulfide

Na_2SO_4: Salt Cake (Sodium Sulfate)

Na_2SO_3: Sodium Sulfite

NCASI: National Council of the Paper Industry for Air and Stream Improvement

NH_3: Ammonia

No.: Number

NPDES: National Pollutant Discharge Elimination System

NSPS: New Source Performance Standards

NSSC: Neutral Sulfite Semi-Chemical

O: Oxygen (bleach)

O_3: Ozone

O&M: Operation & Maintenance

P: Peroxide (bleach)

PA: Peracetic Acid (bleach)

PCB: Polychlorinated Biphenyl

PCP: Pentachlorophenol

PFTBA: Perfluorotributylamine

pH: alkalinity

PIMA: Paper Industry Management Association

pkg: packaging

POTW or POTWs: Publicly Owned Treatment Works

ppb: parts per billion

PPRIC: Pulp and Paper Research Institute of Canada

Pt-Co units: Platinum Cobalt Units

ppm: parts per million

%: percent

Prf: Proof

Print: Printing

prod.: production

PS: Post Storage

PSES: Performance Standards for Existing Sources

psi: pounds per square inch

psig: pounds per square inch gauge

PSNS: Performance Standards for New Sources

purch: purchased

PVA: Polyvinylacetate

QC/QA: Quality Control/Quality Assurance

RBC: Rotating Biological Contactor

RCRA: Resource Conservation Recovery Act

RWL: Raw Waste Load

S: Surface Condenser

S&A: Sampling and Analysis

San: Sanitary

sat: saturated

SB: Settling Basin

SCOT: Support-Coated Open Tubular Capillary Column

Semi-chem: Semi-chemical

SO_2: Sulfur Dioxide

spec: speciality

sq ft: square feet

sq m: square meter

sq m/g: square meter per gram

SRP: Salt Recovery Process

SS: Stainless Steel

SSL: Spent Sulfite Liquor

Std Meth: Standard Methods

Str: Structural

SW: Softwood

SWK: Softwood Kraft

t: ton

TAPPI: Technical Association of the Pulp and Paper Industry

TCP: Trichlorophenol

TDH: Total Dynamic Head

Tech: Technical

Temp: Temperature

TMP: Thermo-Mechanical Pulp

TOC: Total Organic Carbon

TOD: Total Oxygen Demand

ton: 2000 pounds

t/d or tpd: tons per day

TS: Total Solids

TSS: Total Suspended Solids

TVS: Total Volatile Solids

U: Unknown

UBK: Unbleached Kraft

Unctd: Uncoated

USSR: Union of Soviet Socialist Republics

Vibra: Vibrating

VOA: Volatile Organic Acid

Vr: Vapor recompression

vs: versus

V/Q: Volume to flow

v/v: percent by volume

W: Water Soak

WATDOC: Canada's Inland Waters Directorate

WF: Wood Flour

w/: with

w/o: without

WP: Wastepaper

WW: White Water

w/w: water to water

µ: micro

ug/l: micrograms per liter

yr: year

Z/A: Zurn/Attisholz

<: less than

≤: less than or equal to

>: greater than

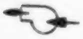
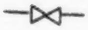
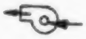
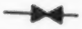
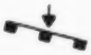
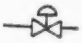
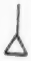
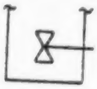
≥: greater than or equal to

+: plus

-: minus

LEGEND OF SYMBOLS ON FIGURES

PROCESS DESIGNATIONS

	FLOW DIRECTION		PUMP
	VALVE (NORMALLY OPEN)		BLOWER
	VALVE (NORMALLY CLOSED)		SHOWERS
	CONTROL VALVE (SHOWN OPEN)		DISTRIBUTION NOZZLE
	FLOOR DRAIN		AGITATOR

INSTRUMENTATION

• • • •	INSTRUMENTATION LINES	LA	LEVEL ALARM
● • • •	PROBE	LC	LEVEL CONTROL
○ • • •	CONTROLLER	LCA	LEVEL CONTROL & ALARM
C	CONDUCTIVITY CONTROL	LIC	LEVEL INDICATOR & CONTROL
CC	CONSISTENCY CONTROL	pHC	pH CONTROL
CA	CONDUCTIVITY CONTROL & ALARM	RC	REMOTE CONTROL
FC	FLOW CONTROL	TC	TEMPERATURE CONTROL
HLA	HIGH LEVEL ALARM	TRC	TEMPERATURE RECORDER & CONTROL

APPENDIX D

REFERENCES

1. *Natural Resources Defense Council, Inc., et al.* v. *Train*, United States District Court for the District of Columbia, (8 ERC 2120), June 7, 1976.

2. *Natural Resources Defense Council, Inc., et al.* v. *Costle*, United States District Court for the District of Columbia, (12 ERC 1833), March 9, 1979.

3. *Federal Register*, 39 FR 16578, 40 CFR 431, May 9, 1974.

4. *Federal Register*, 39 FR 18742, 40 CFR 430, May 29, 1974.

5. *Federal Register*, 42 FR 1398, 40 CFR 430, January 6, 1977.

6. *Weyerhaeuser Co., et al.* v. *Douglas Costle*, United States Court of Appeals for the District of Columbia Circuit, September 5, 1978.

7. *Federal Register*, 45 FR 15952, 40 CFR 430, March 12, 1980.

8. *Federal Register*, 46 FR 1430, 40 CFR Parts 430 and 431, January 6, 1981.

9. *Federal Register*, 42 FR 6476, 40 CFR 128, February 2, 1977.

10. *Rationale for the Development of BAT Priority Pollutant Parameters*, U.S. Environmental Protection Agency, Effluent Guidelines Division, Washington, D.C., May 24, 1977.

11. Choi, P.S.K., W.J. Mueller, J.A. Jacomet, D.L. Hessel, J.A. Gerling, and T.J. Collier, *Multi-Media Pollution Assessment in Pulp, Paper, and other Wood Products Industry*, December 1976.

12. *Priority Pollutant Information and Data Assessment*, Edward C. Jordan Co., Inc., Portland, Maine, June 1977.

13. *Survey Form--Pulp, Paper,and Paperboard Industry, Part I and Part II*, U.S. Environmental Protection Agency, October 1977.

14. *Survey Form--Pulp, Paper, and Paperboard Industry, Errata Sheets*, U.S. Environmental Protection Agency, October 1977.

15. *Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants*, U.S. Environmental Protection Agency, Cincinnati, Ohio, April 1977.

16. *Procedures for Screening of Pulp, Paper, and Paperboard Effluents for Fourteen Nonconventional Pollutants*, U.S. Environmental Protection Agency, Washington, D.C., December 1980.

17. *Screening Program Work Booklet*, Edward C. Jordan Co., Inc., September 1977.

18. *Standard Methods for the Examination of Water and Wastewater*, American Public Health Association, American Water Works Association and Water Pollution Control Federation, 14th Edition, 1975.

19. *Process Data - Verification Program Mill Survey for Priority Pollutants*, U.S. Environmental Protection Agency, Washington, D.C., July 1978.

20. *Verification Program Work Booklet*, Edward C. Jordan, Co., Inc., July 1978 (and all subsequent revisions).

21. Private Communication with National Council of the Paper Industry for Air and Stream Improvement, Inc., December 15, 1978.

22. *An Investigation of Improved Procedures for Measurement of Mill Effluent and Receiving Water Color*, National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI), Technical Bulletin No. 253, December 1971.

23. *Federal Register*, 44 FR 69464, 40 CFR 136, December 3, 1979.

24. *Procedures for Analysis of Pulp, Paper, and Paperboard Effluents for Toxic and Nonconventional Pollutants*, U.S. Environmental Protection Agency, Washington, D.C., December 1980.

25. *Long-Term Sampling Work Booklet*, Edward C. Jordan Co., Inc.; April, 1981.

26. *Long-Term Sampling Work Booklet for Pulp, Paper, and Paperboard Mills Manufacturing Deink Products*, Edward C. Jordan Co., Inc., September, 1981.

27. *Economic Impact Analysis of Effluent Limitations and Standards for the Pulp, Paper, and Paperboard Industry*, U.S. Environmental Protection Agency, October 1982.

28. *Pulp and Paper Manufacture*: *The Pulping of Wood*, *Vol. I*, 2nd Edition, McGraw-Hill Book Co., New York, 1969.

29. Rydholm, S.A., *Pulping Processes*, Interscience Publishers, New York, 1965.

30. Scott, R.H. and H.K. Willard, "The U.S. Sulfite Industry Faces Present and Future Waste Control Needs," *TAPPI*, Vol. 56, No. 9, September 1973.

31. Gehm, H.W., *State-of-the-Art Review of Pulp and Paper Waste Treatment*, EPA Contract No. 68-01-0012, April 1973.

32. Brown, R.W., *et al*., "Semi-Chemical Recovery Processes and Pollution Abatement," *Pulp and Paper Magazine of Canada*, T-202, March 1960.

33. Hanson, James P., "No Sulfur Pulping Pushing Out NSSC Process at Corrugating Medium Mills," *Pulp and Paper*, Vol. 52, No. 3, March 1978.

34. TAPPI Standard Method T217m-48.

35. *The Bleaching of Pulp*, *TAPPI*, Monograph Series, No. 27, 1963.

36. *Lockwood's Directory of the Paper and Allied Trades*, Vance Publishing, 1978 Edition.

37. *Paper and Pulp Mill Catalog and Engineering Handbook*, Paper Industry Management Association (PIMA), 1978 Edition.

38. *Post's Pulp and Paper Directory*, Miller Freeman Publications, San Francisco, California, 1979 Edition.

39. *Aerated Lagoon Treatment of Sulfite Pulping Effluents*, Report to the U.S. Environmental Protection Agency, Water Pollution Control Research Series Program No. 12040 ELW, December 1970.

40. Strier, Murray, *Treatability of Organic Priority Pollutants - Part C - Their Estimated (30 Day Average) Treated Effluent Concentrations - A Molecular Engineering Approach*, 1978.

41. *Development Document for Existing Source Pretreatment Standards for the Electroplating Point Source Category*, U.S. Environmental Protection Agency, Washington, D.C., EPA 440/1-79-003, August 1979.

42. *Development Document for Proposed Effluent Limitations Guidelines and Standards for the Metal Finishing Point Source Category*, EPA 440/1-82/091b, August 1982.

43. *Fate of Priority Pollutants in Publicly Owned Treatment Works*, U.S. Environmental Protection Agency, EPA 440/1-82/303, September 1982.

44. *Development Document for Proposed Effluent Limitations Guidelines and Standards for Control of Polychlorinated Biphenyls in the Deink Subcategory of the Pulp, Paper, and Paperboard Point Source Category*, U.S. Environmental Protection Agency, Washington, D.C., October 1982.

45. *Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Builders' Paper and Roofing Felt Segment of the Builders' Paper and Board Mills Point Source Category*, U.S. Environmental Protection Agency, Washington, D.C., EPA 440/1-74-026a, May 1974.

46. *Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Unbleached Kraft and*

Semi-chemical Pulp Segment of the Pulp, Paper, and Paperboard Mills Point Source Category, U.S. Environmental Protection Agency, Washington, D.C., EPA 440/I-74-025-a, May 1974.

47. Development Document for Interim Final and Proposed Effluent Limitations Guidelines and Proposed New Source Performance Standards for the Bleached Kraft, Groundwood, Sulfite, Soda, Deink, and Non-Integrated Paper Mills Segment of the Pulp, Paper and Paperboard Point Source Category - Vol. 1 & 2, U.S. Environmental Protection Agency, Washington, D.C., EPA 440/1-76/047-A, January 1976.

48. Development Document for Effluent Limitations Guidelines for the Bleached Kraft, Groundwood, Sulfite, Soda, Deink, and Non-Integrated Paper Mills Segment of the Pulp, Paper, and Paperboard Point Source Category, U.S. Environmental Protection Agency, Washington, D.C., EPA 440/1-76/047-b, December 1976.

49. Ekono, Inc., "Process Design Manual for Pollution Control in the Pulp and Paper Industry, Part II, Water and Solids," Unpublished Project for EPA Contract No. 68-01-1821, 1973.

50. Thompson, R., P.J. Savage, and C.Y. Chai, "In-Plant Reduction of Suspended Solids at Espanola," 1974 Air and Stream Improvement Conference, Toronto, Ontario.

51. SSVL, "The Environmental Care Project Half Year Report - January 1973," Printed for Swedish Pulp and Paper Mission to North America, January 1973.

52. SSVL Environmental Care Project- Technical Summary, Stockholm, Sweden, 1974.

53. Kramer, J. D., C.F. Cornell, D.C. Pryke, and G. Rowlandson, "Spill and Effluent Control in the Closed-Cycle Bleached Kraft Pulp Mill," TAPPI Environmental Conference, 1979.

54. Czappa, D. J., "In-Mill Close-up," TAPPI, Vol. 61, No. 11, November 1978.

55. Becker, K.E., "Crown Simpson Finds Process Revisions Less Costly than Primary Treatment," TAPPI, Vol. 62, No. 6, June 1979.

56. A Study of the Relation Between Residual Soda and Water-Extractable Components of Vacuum Drum Washed Kraft Pulp and of Repulped Corrugated Container Effluent Characteristics, NCASI, Stream Improvement Technical Bulletin No. 277, October 1974.

57. Edde, H. and E. Sebbas - Bergstrom, "Internal Pollution Controls in the Pulping Industry," Journal WPCF, Vol. 46 No. 11, 1974.

58. Rapson, William H. "Using Caustic Extraction Effluent in Production of Bleached Pulp," Canadian Patent 802,084, December 24, 1968.

59. Twitchell, J. and L. Edwards, "Kraft Mill Material Balance Calculations for Brown Stock Washing, Screening and Oxygen Bleaching," TAPPI, Vol. 57, No. 9, September 1974.

60. "Summary Report on the Evaluation of Internal Process Control Technology Used in the Pulp and Paper Industry for Effluent Reduction," Unpublished Contractor's Report to EPA, October, 1977.

61. CIP Research, Ltd., Water Re-use and Recycle in Bleacheries, Distributed by CPAR Secretariat, Canadian Forestry Service, Ottawa, Ont., CPAR Report No. 47-1, 1972.

62. Kalish, John, "Swedish Mill Modernizes and Looks to New Future for Sulfite Process," Pulp and Paper, Vol. 51, No. 9, September 1977.

63. Internal Memorandum from H.J. Wilk (ITT Rayonier Inc., Olympia Research Division) Concerning Sulfite Effluent BOD, July 25, 1975.

64. Rath, P., "Process Wastewater: Reclamation or Disposal," TAPPI Environmental Conference, April 26-28, 1976.

65. "Pollution Reduction by Internal Measures at Bleached Kraft Mills," Paper Trade Journal, Vol. 156, No. 44, October 1972.

66. "Proceedings of the 1976 NCASI Central-Lakes States Regional Meeting," NCASI Special Report 77-02, March 1977.

67. Relation Between Process Water Quality Characteristics and Its Reuse Potential in Combination Board Mills, NCASI Technical Bulletin No. 282, September 1975.

68. The Relationship Between Process Water Quality Characteristics and its Reuse Potential in the Nonintegrated Manufacture of Tissue and Toweling, NCASI Technical Bulletin No. 289, November 1976.

69. Casey, J.P., Pulp and Paper Chemistry and Chemical Technology, 2nd Edition, Interscience Publishers, Inc., New York, 1960.

70. Broughton, Robert W., "Needled Felts Get Another Lease on Life With New Shower Method," Pulp and Paper, Vol. 43, No. 11, November 1969.

71. Mulford, J.E. and R. Cooke, "Reuse of Nash Vacuum Pump Seal Water," TAPPI, Vol. 52, No. 12, December 1969.

72. Brown, G.W., "Computer Simulation of Papermaking to Evaluate Water Reuse Strategies," Mead Corporation, (Unpublished Paper).

73. David, E., *et al*., "Oxygen Bleaching - Two Years of Operating Experience in France," *Pulp and Paper International*, June 1976.

74. Myburgh, C.J., "Operation of the Enstra Oxygen Bleaching Plant," *TAPPI*, Vol. 57, No. 5, May 1974.

75. Andersson, K.A., "The Non-Polluting Bleach Plant," *TAPPI*, Vol. 60, No. 3, March 1977.

76. Rapson, W.H., D.W. Reeve, *et al*., "The Closed Cycle Bleached Kraft Pulp Mill - 1978," *TAPPI*, 1978.

77. Rapson, W.H., D.W. Reeve, and J.A. Isbister, "The Closed Cycle Concept Kraft Mill at the Great Lakes Paper Co., Ltd. - A Status Report," Proceedings of the PIMA Conference in Minneapolis, Minnesota, June 22, 1978.

78. Anderson, L.G. and S. Lindberg, "Uddenolm Cleans Bleach Effluents and Solves Chlorine Removal Question," *Pulp and Paper International*, Vol. 16, No. 6, June 1974.

79. Lowe, K.E., "Chesapeake Launches Oxygen Bleaching," *Pulp and Paper*, October 1973.

80. MacLeod, M., "Evolution and Revolution in Pulp Bleaching - A Current Perspective," *Pulp and Paper*, May 1976.

81. Carpenter, W.L., I. Gelman, *et al*., "A Comparison of Effluent Characteristics from Conventional and Oxygen Bleaching Sequences - Results of a Laboratory Study," CPPA-TAPPI International Pulp Bleaching Conference, Vancouver, B.C., September 1973.

82. Mattson, D., Unpublished Trip Report on ERCO Envirotech - Closed Cycle Kraft Mill, E.C. Jordan Co., Washington, D.C., October 19, 1978.

83. Cox, C., Unpublished Trip Report to Great Lakes Paper Co., Thunder Bay, Ontario, October 1, 1980.

84. Gall, R.J. and F.H. Thompson, "The Anti-Pollution Sequence - A New Route to Reduced Pollutants in Bleach Plant Effluent," *TAPPI*, Vol. 56, No. 11, November 1973.

85. Moy, W.A., K. Sharpe, and G. Betz, "New Bleaching Sequence for SBK, Cuts Effluent Color and Toxicity," *Pulp and Paper*, *Canada*, Vol. 76, No. 5, May 1975.

86. Jenkin, T.E., "Eastex Displacement Bleaching Update," *TAPPI*, Alkaline Pulping Conference Preprint, 1976.

87. *Displacement Bleaching*, Unpublished Report on Mill Visit to Weyerhaeuser Corp., Plymouth, N.C., E.C. Jordan Co., March 14, 1979.

88. Gould, M. and J. Walzer, "Mill Waste Treatment by Floatation at Delair," *Chem 26*, November 1972.

89. Fuller, R.S., "Screening of Effluents," *TAPPI*, Vol. 56, No. 6, June 1973.

90. Easty, Dwight B., L.G. Borchardt, and B. A. Wabers, Institute of Paper Chemistry, *Removal of Wood Derived Toxics from Pulping and Bleaching Wastes*, U.S. Environmental Protection Agency, Cincinnati, OH, EPA 600/2-78-031, 1978.

91. *Investigation of Chlorinated and Nonchlorinated Compounds in the Lower Fox River Watershed*, U.S. Environmental Protection Agency, EPA 905/3-78-004, Chicago, Illinois, September 1978.

92. Walden, C.C. and J.C. Mueller, B.C. Research, *Investigation of the Effect of BOD Reduction Systems on Toxicity*, Distributed by CPAR Secretariat, Canadian Forestry Service, Ottawa, Ontario, as CPAR Report No. 150-1, 1973.

93. Leach, J.M., J.C. Mueller, and C.C. Walden, "Biodegradability of Toxic Compounds in Pulp Mill Effluents," Presented at 63rd Annual Meeting of the Technical Section, CPPA, February 1977.

94. Tracy, J.C., "Secondary Waste Treatment Nutrient and Aeration Studies," *Southern Pulp and Paper Manufacturer*, February 1970.

95. Eckenfelder, W.W., Jr., *Industrial Waste Water Control*, McGraw-Hill Book Co., New York, 1966.

96. Edde, J., "Field Research Studies of Hydraulic Mixing Patterns in Mechanically Aerated Stabilization Basin," Proceedings International Congress on Industrial Waste Waters, Stockholm, Sweden, 1970.

97. McKeown, J.J. and D.B. Buckley, "Mixing Characteristics of Aerated Stabilization Basins," *TAPPI*, 8th Water and Air Conference, 1971.

98. Chandrasekaran K., R.J. Reis, G.C. Tanner, and H.I. Rogers, "Removing Toxicity in an Aerated Stabilization Basin," *Pulp and Paper, Canada*, Vol. 79, No. 10, October 1978.

99. McKeown, J.J., *The Effect of Temperature on Treatment Plant Performance and Related Temperature Studies*, NCASI Technical Bulletin No. 312, 1978.

100. Metcalf & Eddy, Inc., *Wastewater Engineering*, McGraw-Hill Book Co., 1972.

101. Technical data supplied by Union Carbide Corp., Nov. 29, 1977.

102. Harvey, E. and H. Vaandering, "NSFI Pilots UNOX System for Secondary Treatment," *Pulp and Paper, Canada*, Vol. 76, No. 2, February 1975.

103. Brock, T.D., *Biology of Microorganisms*, Prentice-Hall, Inc., 1970.

104. Van Soest, R. and D. Guatam," Tertiary Treatment Quality for a Secondary System Utilizing the Zurn-Attisholz Process," Proceedings of the 28th Industrial Waste Conference, Lafayette, Indiana, 1973.

105. Rice, B. and R. Van Soest, "Practical Experience of a New Effluent Plant One Year After Start-Up," *TAPPI*, Vol. 58, No. 10, October 1975.

106. "Two Stage Activated Sludge Better Than Single for Toxicity Reduction," *Canadian Pulp and Paper Industry*, November 5, 1977.

107. *An Assessment of Kraft Bleachery Effluent Toxicity Reduction Using Activated Sludge*, Wastewater Technology Centre, Fisheries and Environmental Protection Service, Environment Canada, EPS 4-WP-77-3, 1977.

108. Gillespie, W.J., D.W. Marshall, and A.M. Springer, "A Pilot Scale Evaluation of Rotating Biological Surface Treatment of Pulp and Paper Wastes", TAPPI Environmental Conference, April 17-19, 1974.

109. T.W. Beak Consultants, Ltd. and NCASI, *Development of Biosurf Process Parameters for the Pulp and Paper Industry*, Distributed by CPAR Secretariat, Canadian Forestry Service, Ottawa, Ontario, as CPAR Report No. 102-1 and 102-2, 1973-74.

110. T.W. Beak Consultants, Ltd., *Anaerobic Contact Filter Process for the Treatment of Waste Sulfite Liquor*, Distributed by CPAR Secretariat, Canadian Forestry Serivce, Dept. of the Environment, Ottawa, Ontario, as CPAR Report No. 103, 1973.

111. McKinney, R.E., *Microbiology for Sanitary Engineers*, McGraw-Hill Book Company, 1962.

112. Clark, J.W. and W. Viesman Jr., *Water Supply and Pollution Control*, International Textbook Company, 1970.

113. Streeter, H.W. and E.B. Phelps, *A Study of Pollution and Natural Purification of the Ohio*, Public Health Bulletin No. 146, United States Public Health Service, February 1925.

114. Vamvakias, J.G. and J.P. Miller, "Temperature Response of Aerated Stabilization Basins With and Without Nutrients," Fifth Paper-Industry and Stream Improvement Conference, Canadian Pulp and Paper Association, Technical Paper T87.

115. T.W. Beak Consultants, Ltd., *Biological Treatment and Toxicity Studies*, Environment Canada, Environmental Protection Service, Economic and Technical Review Report EPS3-WP-73-6, Ottawa, Canada, 1973.

116. McKeown, J.J., D.B. Buckley, and I. Gellman, "A Statistical Documentation of the Performance of Activated Sludge and Aerated Stabilization Basin Systems Operating in the Paper Industry," Purdue Industrial Waste Conference XXIX, 1974.

117. *Manual of Practice -- Biological Waste Treatment in the Pulp and Paper Industry*, NCASI Technical Bulletin No. 214, April 1968.

118. Burns, O.B., Jr., and W.W. Eckenfelder Jr., "A Statistical Study of Five Years Operation of the West Virginia Pulp and Paper Company's Waste Treatment Plant," Purdue Industrial Waste Conference XVIII, 1963.

119. Adams, C.E. and W.W. Eckenfelder Jr., "Nitrification Design Approach for High Strength Ammonia Wastewaters," *Journal WPCF*, March 1977.

120. Adams, C.E., "Removing Nitrogen From Wastewater," *Environmental Science & Technology*, August 1973, pp. 696-701.

121. *Process Design Manual for Nitrogen Control*, U.S. Environmental Protection Agency, Technology Transfer, October 1975.

122. Culp, R.L. and G.L. Culp, *Advanced Wastewater Treatment*, Van Nostrand Reinhold, New York, 1971.

123. Environmental Science Services Corporation, *Water Resource Management Series, Volume 1 - Manual of Treatment Processes*, 1970.

124. Liptak, B.G., *Environmental Engineer's Handbook, Vol. 1 - Water Pollution*, Chilton Book Co., Radnor, Pa., 1974.

125. *Operation of Wastewater Treatment Plants*, Manual of Practice No. 11, Water Pollution Control Federation, Lancaster Press, Lancaster, Pa., 1976.

126. Stumm, W. and J.J. Morgan, *Aquatic Chemistry*, Wiley Interscience, 1970.

127. Rebhun, M., C.H. Saliternik, and H. Sperber, "Purification of Paper Mill Effluents by Flocculation," *TAPPI*, Vol. 50, No. 12, December 1967.

128. Ives, K.J., "Theory of Operation of Sludge Blanket Clarifiers," Proceedings - The Institution of Civil Engineers, Vol. 39, Session 1967-1968, January 1968.

129. *Filtration and Chemically Assisted Clarification of Biologically Treated Pulp and Paper Mill Industry Wastewaters*, Draft Report to the U.S. Environmental Protection Agency, Edward C. Jordan Co., Inc., 1979.

130. Rice, N., A.A. Kalinske, and W.I. Arnold, *A Pilot Study of Advanced Wastewater Treatment for the Ticonderoga Mill*, August 1977.

131. Personal Communication with Dana Dolloff, International Paper Co., June 26, 1980.

132. Amberg, H.R., I. Gellman, and R.H. Scott, "The Status of Water Pollution Control in the Soviet Union," *TAPPI*, Vol. 58, No. 11, November 1975.

133. Scott, R.H., "Sophisticated Treatment of Baikal Pulp Mill in USSR," *Pulp and Paper*, Vol. 44, No. 4, April 1978.

134. *Treatment of Calcium-Organic Sludges Obtained from Lime Treatment of Kraft Pulp Mill Effluents - Part I*, NCASI Technical Bulletin No. 62, 1955.

135. *Treatment of Calcium-Organic Sludges Obtained From Lime Treatment of Kraft Pulp Mill Effluents - Part II*, NCASI Technical Bulletin No. 75, 1955.

136. Oswalt, J. L., and J.G. Land Jr., *Color Removal from Kraft Pulp Mill Effluents by Massive Lime Treatment*, EPA Project 12040 DYD, 1973.

137. Gould, Matthew, "Color Removal from Kraft Mill Effluent by an Improved Lime Process," *TAPPI*, Vol. 56, No. 3, March 1973.

138. Gould, Matthew, "Physical-Chemical Treatment of Pulp Mill Wastes--Woodland, Maine," Proceedings of the Purdue International Waste Conference, 1970.

139. Smith, O.D., R.M. Stein, and C.E. Adams Jr., "How Mills Cope With Effluent Suspended Solids," *Paper Trade Journal*, Vol. 159, No. 17, July 1975.

140. Peterson, R.R. and J.L. Graham, CH2M Hill, Inc., *Post Biological Solids Characterization and Removal from Pulp Mill Effluents*, EPA 600/2-79-037, January 1979.

141. *Preliminary Data Base for Review of BATEA Effluent Limitations Guidelines, NSPS, and Pretreatment Standards for the Pulp, Paper, and Paperboard Point Source Category*, Edward C. Jordan Co., Inc., June 1979.

142. Amberg, H.R., Crown Zellerbach Corp., Comments on E.C. Jordan Draft Report, "Preliminary Data Base for Review of BATEA Effluent Limitations Guidelines, NSPS, and Pretreatment Standards for the Pulp, Paper, and Paperboard Point Source Category," September 1979.

143. Cashen, R.F., St. Regis Paper Co., Comments on E.C. Jordan's Draft Report, "Preliminary Data Base for Review of BATEA Effluent Limitations Guidelines, NSPS, and Pretreatment Standards for the Pulp, Paper, and Paperboard Point Source Category," September 18, 1979.

144. Button, E.F., ITT Rayonier Inc., Comments on E.C. Jordan's Draft Report, "Preliminary Data Base for Review of BATEA Effluent Limitations Guidelines, NSPS, and Pretreatment Standards for the Pulp, Paper, and Paperboard Point Source Category," September, 1979.

145. Barton, Curtis A., The Proctor & Gamble Co., Comments on E.C. Jordan's Draft Report, "Preliminary Data Base for Review of BATEA Effluent Limitations Guidelines, NSPS, and Pretreatment Standards for the Pulp, Paper, and Paperboard Point Source Category," September 1979.

146. National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI), "Summary of Data-Chemically Assisted Clarification of Biologically Treated Wastewaters," Presented in Meeting with U.S. EPA/Edward C. Jordan Co., Portland, Maine, February 7, 1980.

147. Olthof, M.G., "Color Removal from Textile and Pulp and Paper Wastewaters by Coagulation," Vanderbilt University, Ph.D. Thesis, 1974.

148. Olthof, M.G. and W.W. Eckenfelder Jr., " A Laboratory Study of Color Removal from Pulp and Paper Waste Waters by Coagulation," TAPPI, Vol. 57, No. 8, August 1974.

149. Berov, M.B., et al., "Optimum Conditions for Chemical Treatment of Effluents," Bum. Prom., No. 2: 17, 1975 (Russia); Abstract Bulletin Institute of Paper Chemistry, Vol. 46, No. 2, 1975.

150. Dugal, H.S., J.O. Church, R.M. Leekley, and J.W. Swanson, "Color Removal in a Ferric Chloride - Lime System," TAPPI, Vol. 59, No. 9, September 1976.

151. Rush, R.J. and E.E. Shannon, "Review of Colour Removal Technology in the Pulp and Paper Industry," Environment Canada, 1975.

152. Vincent, D.L., Colour Removal From Biologically Treated Pulp and Paper Mill Effluents, Distributed by CPAR Secretariat, Canadian Forestry Service, Dept. of the Environment, Ottawa, Ontario, as CPAR Report No. 210-1, March 31, 1974.

153. Environmental Quality Systems, Inc., Technical and Economic Review of Advanced Waste Treatment Processes, Office of the Chief of Engineers, U.S. Army Corps of Engineers, 1973.

154. Process Design Manual for Carbon Adsorption, U.S. Environmental Protection Agency, Technology Transfer, October, 1973.

155. Timpe, W.G., et al., "Selection of Pilot Treatment Systems in the Use of Activated Carbon for Water Renovation in Kraft Pulp and Paper Mills," FWQA Report, Serial No. 028-70, Pensacola, Florida, December 1970.

156. Bishop, D.F., et al., "Studies on Activated Carbon Treatment," Journal WPCF, Vol. 39, No. 2, 1967.

157. Hansen, S.P. and F.J. Burgess, "Carbon Treatment of Kraft Condensate Wastes," TAPPI, Vol. 51, No. 6, June 1968.

158. Timpe, W.G. and E.W. Lang, "Activated Carbon Treatment of Unbleached Kraft Effluent for Reuse - Pilot Plant Results," TAPPI Environmental Conference, San Francisco, California, May 1973.

159. Davis, John C., "Activated Carbon -- Prime Choice to Boost Secondary Treatment," Chemical Engineering, April 11, 1977.

160. Callahan, W.F. and A.B. Pincince, "An Activated Carbon Wastewater Treatment System at Fitchburg, Mass.," TAPPI, Vol. 60, No. 11, November 1977.

161. Taylor, James L., "Full Scale Experience with Activated Carbon Treatment of Paper Industry Wastewater," Preceedings of 1979 NCASI Northwest Regional Meeting, NCASI Special Report No. 80-03, February 1980.

162. T.W. Beak Consultants, Ltd., Optimization of Physical-Chemical Treatment Processes, Distributed by CPAR Secretariat, Canadian Forestry Service, Ottawa, Ontario, as CPAR Report No. 176-1, 1974.

163. Kimura R. and K. Izumisawa, "Approach to Entirely Closed Boardmill by Activated Carbon," Japan TAPPI, KAMI PAGIKYOSHI, Vol. 30, No. 1, January 1976.

164. Smith, D.R. and H.F. Berger, "Waste Water Renovation," TAPPI, Vol. 51, No. 10, October 1968.

165. Weber, W.J., Jr. and J.C. Morris, "Kinetics of Adsorption in Columns of Fluidized Media," Journal Water Pollution Control Federation, Vol. 37, No. 4, April 1965.

166. DeWalle, F.B., E.S.K. Chian, and E.M. Small, "Organic Matter Removal By Powdered Activated Carbon Added to Activated Sludge," Journal Water Pollution Control Federation, April, 1977.

167. Hutton, David G., "Removal of Priority Pollutants with a Combined Powdered Activated Carbon - Activated Sludge Process," Proceedings of the 179th National American Chemical Society Meeting in Houston, Texas, March 23-28, 1980.

168. Hutton, D.G. and F.L. Robertaccio, U.S. Patent 3,904,518, September 9, 1975.

169. Crame, L.W., "Activated Sludge Enhancement: A Viable Alternative to Tertiary Carbon Adsorption," Proceedings of the Open Forum on Management of Petroleum Refining Wastewater, June 1977.

170. Grieves, C.G., *et al*., "Powdered Carbon Improves Activated Sludge Treatment," *Hydrocarbon Processing*, October 1977.

171. Dehnert, J.F., "Case History - The Use of Powdered Activated Carbon with a Biodisc-Filtration Process for Treatment of Refinery Wastes," Proceedings of the Open Forum on Management of Petroleum Refinery Wastewater, June 1977.

172. Heath, W.H., Jr., "Combined Powdered Activated Carbon - Biological ("PACT") Treatment of 40 MGD Industrial Waste," Presented to Symposium on Industrial Waste Pollution Control at the 173rd American Chemical Society National Meeting, March 1977.

173. Robertaccio, F.L., "Combined Powdered Activated Carbon-Biological Treatment: Theory and Results," Proceedings of the Open Forum on Management of Petroleum Refinery Wastewaters, June 1977.

174. Ng, K.S., *Pilot Plant Evaluation of Mechanical Foam Breaking and Jet Foam Generation Systems*, Distributed by CPAR Secretariat, Canadian Forestry Service, Ottawa, Ontario, as CPAR Report No. 508-1, 1976.

175. Brunner, C.A. and D.G. Stephan, "Foam Fractionation," *Industrial and Engineering Chemistry*, Vol. 57, No. 5, May 1965.

176. Miller, J.K.P. and L.K. Legatski, "Investigation of a High Pressure Foam Wastewater Treatment Process," Federal Water Quality Adm., Water Pollution Control Research Series 17030 ESX 04/70, 1970.

177. Ng, K.S., *Study of Foam Separation as a Means of Detoxifying Bleached Kraft Mill Effluents*, Distributed by CPAR Secretariat, Canadian Forestry Service, Ottawa, Ontario, as CPAR Report No. 233-1 and 2, 1974-75.

178. Walden, C.C. and J.C. Mueller, B.C. Research, *Investigation of the Effect of BOD Reduction Systems on Toxicity*, Distributed by CPAR Secretariat, Canadian Forestry Service, Department of the Environment, Ottawa, Ontario, as CPAR Report No. 150-2, 1974.

179. Bliss, F.R., *Polishing of Paper Mill Effluents by Microstraining*, Strathmore Paper Co., (Unpublished Paper), 1973.

180. Bliss, F.R., *Papermill Wastewater Treatment by Microstraining*, U.S. Environmental Protection Agency, Cincinnati, OH, EPA 600/2-76-252, 1976.

181. Oher, Klaus, "Electrochemical Decolorization of Kraft Mill Effluents," *Journal Water Pollution Control Federation*, February 1978.

182. Das Gupta, Sankar and S. Mohanta, "Electrochemical Process for Treatment of Kraft Mill Effluent," Distributed by CPAR Secretariat, Canadian Forestry Service, Department of the Environment, Ottawa, Ontario, as CPAR Report No. 523-1, 1976.

183. Personal Communication with Dr. Sankar Das Gupta, HSA Reactors, Ltd.

184. Selivanov, V.G., V.P. Svitel'skii, V.G. Ryumin, and N.B. Samborskii, "Purification of Effluents from the Manufacture of Paper and Board by Electrochemical Method," *Bumazh. Prom*. No. 8:24-25, August 1976.

185. Herer, D.O. and F.E. Woodard, "Electrolytic Coagulation of Lignin From Kraft Mill Bleach Plant Wastewaters," *TAPPI*, Vol. 59, No. 1, January 1976.

186. Chan, A., D.W. Herschmiller, and D.R. Manolescu, Environcon, Ltd., *Ion Floatation for Color Removal From Kraft Mill Effluents*, Distributed by CPAR Secretariat, Canadian Forestry Service, Department of the Environment, Ottawa, Ontario, as CPAR Report No. 93-1, 1973.

187. Barclay, H.G., C. Heitner, and S. Prahacs, *Review of Catalytic Oxidation of Pulp and Paper Mill Effluents*, Distributed by CPAR Secretariat, Canadian Forestry Service, Ottawa, Ontario, as CPAR Report No. 147-1, 1973.

188. Hough, G.W. and R.W. Sallee, "Treatment of Contaminated Condensates," *TAPPI*, Vol. 60, No. 2, February 1977.

189. East, R.C. PhD., *Handbook of Chemistry and Physics*, CRC Press, 1974-75.

190. Wilson, M.A., R. LeBlanc, and I. Middelraad, "Reduction of Toxicity of Condensates from Sulfate Waste Liquor Evaporators," Distributed by CPAR Secretariat, Canadian Forestry Service, Ottawa, Ontario, as CPAR Report No. 324-1, 1975.

191. Liem, A.J., V.A. Naish, and R.S. Rowbottom, "An Evaluation of the Effect of Inplant Treatment Systems on the Abatement of Air and Water Pollution from a Hardwood Kraft Pulp Mill," Distributed by CPAR Secretariat, Canadian Forestry Service, Ottawa, Ontario, as CPAR Report No. 484-1, October 1977.

192. Lewell, P.A. and M. Williams, *Ultrafiltration of Sulfite Liquor*, Distributed by CPAR Secretariat, Canadian Forestry Service, Ottawa, Ontario, as CPAR Report No. 8-1F, 1971.

193. Wiley, A.J., L.E. Dambruch, P.E. Parker, and H.S. Dugal, Inst. of Paper Chem., "Treatment of Bleach Plant Effluents by Combined Reverse Osmosis and Freeze Concentration Process," Paper presented at TAPPI Environmental Conference, April 1978.

194. Prahacs, S., A. Wong, and H.G. Jones, "Amine Treatment Process for Decolorization of Pulp Mill Effluents-Laboratory Studies," A.I.Ch.E. Symp. Ser. 70, No. 139, 1974.

195. Prahacs, S. and A. Wong, "The Use of High Molecular Weight Amines for the Purification of Pulp Mill Effluents," Distributed by CPAR Secretariat, Canadian Forestry Service, Ottawa, Ontario, as CPAR Report No. 1-2, 1971.

196. Sanks, Robert L. "Ion Exchange Color and Mineral Removal from Kraft Bleach Wastes," U.S. Environmental Protection Agency, Washington, D.C., EPA-R2-73-255, May 1973.

197. Lindberg, S. and L.B. Lund, "A Nonpolluting Bleach Plant," TAPPI, Vol. 63, No. 3, 1980.

198. Chriswell, C.D., et al., "Comparison of Macroreticular Resin and Activated Carbon as Sorbents," Journal of the American Water Works Association, December 1977.

199. Kim, Byung R., V.L. Snoeyink, and F.M. Saunders, "Adsorption of Organic Compounds by Synthetic Resins," Journal Water Pollution Control Federation, January 1976.

200. Rogers, I.H., J.A. Servizi, and R.W. Gordan, "An Effective Method for the Isolation of Fish-Toxic Organic Solutes from Pulp Mill Effluents," Environment Canada Bi-Monthly Research Notes, Vol. 28, No. 4, 1972.

201. Leach, J.M. and A.N. Thakore, "Identification of the Constituents of Kraft Pulping Effluent that Are Toxic to Juvenile Coho Salmon," Journal of the Fisheries Research Board of Canada, Vol. 30, No. 4, April 1973.

202. Wilson, M.A. and C.I. Chappel, Reduction of Toxicity of Sulfite Mill Effluents, Distributed by CPAR Secretariat, Canadian Forestry Service, Ottawa, Ontario, as CPAR Report No. 49-3, 1974.

203. Proposed Development Document for Effluent Limitations Guidelines and Standards for the Pulp, Paper, and Paperboard and the Builders' Paper and Board Mills Point Source Categories, U.S. Environmental Protection Agency, Washington, D.C., EPA 440/1-80/025-b, December 1980.

204. McKinney, R.E., "Mathematics of Complete-Mixing Activated Sludge, Journal of the Sanitary Engineering Division, Proceedings of the ASCE, May 1962.

205. Gibbons, J.D., Nonparametric Statistical Inference, McGraw-Hill, 1971.

206. Final Development Document for Effluent Limitations Guidelines and Standards for the Timber Products Point Source Category, U.S. Environmental Protection Agency, Washington, D.C., EPA 440/1-81/023, January 1981.

207. Miller and Freund, Probability and Statistics for Engineers, Prentice Hall, 1965.

208. Lilliefors, H., "On the Kolmogorov-Smirnov Tests for Normality with Mean and Variance Unknown," Journal of the American Statistical Association, Vol. 62, 1967.

209. Fisher, R.A., Statistical Methods for Research Workers, 14th Edition, New York, Hafner Publishing Company, 1975.

210. Robert S. Means Co., Building Construction Cost Data 1977, 35th Edition, 1976.

211. Employment and Earnings, U.S. Bureau of the Census, April 1978.

212. Employee Benefits 1977, Chamber of Commerce of the U.S.A., April 1978.

213. Energy User News, A Fairchild Business Newspaper, Vol. 3, No. 32, August 7, 1978.

214. Engineering News Record, March 23, 1978.

215. Monthly Energy Review, U.S. Department of Energy, March 1979.

216. Process Design Manual - Municipal Sludge Landfills, EPA-625/1-78-010, U.S. Environmental Protection Agency, October 1978.

217. Chemical Marketing Reporter, November 6, 1978.

218. Robert S. Means Co., Building Construction Cost Data 1979, 37th Edition, 1978.

219. A Survey of Pulp and Paper Industry Environmental Protection Expenditures and Operating Costs-1976, National Council of the Paper Industry for Air and Stream Improvement, Inc. (NCASI), NCASI Special Report 77-06, August 1977.

220. Edde, H., "Influence of Pulping Yield on the Cost of Modernizing Sulfite Pulp Mill Liquor Recovery," Proceedings of the 1978 TAPPI Environmental Conference.

221. The Energy Resources Company, Disposal Practices for Selected Industrial Solid Wastes, Final Report for the U.S. Environmental Protection Agency, Office of Solid Waste, Contract No. 68-01-5814, May 1980.

222. McKeown, J.J., "Sludge Dewatering and Disposal-A Review of Practices in the U.S. Paper Industry," TAPPI, Vol. 62, No. 8, August 1979.

223. Communication between Joseph Aloisio and Mr. Howard Fullerton of the U.S. Department of Labor, Bureau of Labor Statistics.

CONVERSION TABLE

Multiply (English Units)		By	To Obtain (Metric Units)	
English Unit	Abbreviation	Conversion	Abbreviation	Metric Unit
acre	ac	0.405	ha	hectares
acre-feet	ac ft	1233.5	cu m	cubic meters
British Thermal Unit	BTU	0.252	kg cal	kilogram-calories
British Thermal Unit/pound	BTU/lb	0.555	kg cal/kg	kilogram calories per kilogram.
cubic feet per minute	cfm	0.028	cu m/min	cubic meters per minute
cubic feet per second	cfs	1.7	cu m/min	cubic meters per minute
cubic feet	cu ft	0.028	cu m	cubic meters
cubic feet	cu ft	28.32	l	liters
cubic inches	cu in	16.39	cu cm	cubic centimeters
degree Farenheit	°F	0.555(°F-32)*	°C	degree Centigrade
feet	ft	0.3048	m	meters
gallon	gal	3.785	l	liter
gallon per minute	gpm	0.0631	l/sec	liters per second
gallon per ton	gal/ton	4.173	l/kkg	liters per metric ton
horsepower	hp	0.7457	kw	kilowatts
inches	in	2.54	cm	centimeters
pounds per square inch	psi	0.06803	atm	atmospheres (absolute)

(continued)

Multiply (English Units)		By	To Obtain (Metric Units	
English Unit	Abbreviation	Conversion	Abbreviation	Metric Unit
million gallons per day	MGD	3.7 x 10-3	cu m/day	cubic meters per day
pounds per square inch (gauge)	psi	(0.06805 psi + 1)*	atm	atmospheres
pounds	lb	0.454	kg	kilograms
board feet	b.f.	0.0023	cu m, m3	cubic meters
ton	ton	0.907	kkg	metric ton
mile	mi	1.609	km	kilometer
square feet	ft2	.0929	m2	square meters

* Actual conversion, not a multiplier.